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A LESSON IN COMPARATIVE HISTOLOGY.

WITH PLATE II.

BY CHARLES SEDGWICK MINOT.

ONE of the first scraps of information which a young naturalist is apt to acquire, when he learns something of the history of zoölogy, is the knowledge of the great names of Linné and Cuvier. The reforms effected by these two great men in the methods of studying animated nature would alone secure them enduring fame; when we reflect, however, that they also labored industriously to add to our knowledge, and were successful as investigators as well as reformers, we must yield to the conviction that the honorable prominence assigned to them among naturalists is their just due. After both Linnæus and Cuvier had been dead for years, a German *savant* made a discovery concerning the elementary structure of plants, which revealed the fact that all the parts of plants are built up out of the same units, which have ever since been called cells. This great generalization is now taught to every botany class as one of the fundamental principles of vegetable anatomy and physiology, and the name of its great discoverer, Schleiden, is generally coupled with it. Schleiden made the results of his investigations generally known in the year 1837; and it was only two years later that his friend and countryman, Schwann, published a memoir showing that the same units—the cells—are found in all animals as well.

It is a familiar fact to all, in these days when natural science has penetrated to the schoolhouse and the magazines, that matter consists of molecules, or minute particles, which are themselves composed of other particles still more minute—the atoms. Every mass of matter is made up of molecules, and indefinite numbers of molecules may be added to a mass without essentially

changing anything but its size. In living matter, however, nature presents an exception to the universality of this law; for in living bodies the molecules, which are far smaller than the smallest visible particles, are united to form masses of limited size, which represent so many units of the body, just as we might say the bricks represent so many units of a wall. These units of life, as I may call them at the risk of being misunderstood, are the cells before mentioned. The great material difference, therefore, between living and unorganized bodies was at once demonstrated by the discoveries of Schleiden and Schwann, and it is on this account that naturalists attribute such importance to the work of these two men. In truth Schwann's investigations caused as great a change in the direction pursued by zoölogists in their researches as the reform either of Linnæus or Cuvier. But Schwann unlike his great predecessors did not continually make further discoveries, and has not, as far as I am aware, participated in the work of original research, which has been in progress during his life time, so that to most of us perhaps he already seems a person of the distant past.

Yet during Schwann's lifetime one of the principal labors of zoölogists has been the working out in detail the applications of his generalization, and determining the variations and modifications which cells undergo in the different tissues and species of animals, until finally the subject has assumed an importance even more vast than could at first have been foreseen. It is in fact hardly an exaggeration to say that all our knowledge of animals groups itself about the doctrine of cells, as the central factor upon which all others depend; and whether we labor as physiologists, embryologists or anatomists, we are alike forced ultimately to base all our conclusions, and demonstrate all our theorems by the character and property of cells. In brief, what a knowledge of waves is to the student of sound, a knowledge of cells is to the student of life.

It would be a pleasant task to expatiate at length upon the various bearings of the cell doctrine, for we should deal with many of the fundamental problems of zoölogy, and with some of the most interesting additions to our knowledge in this department of science which have ever been made. This course would take us away from the real subject of this article, the object of which is to give an example of how much may be learned by

the study of the cellular anatomy of even the commonest animals, therefore I must resign for the present the wider and more attractive field, and descend to details, in order to show by a concrete example some of the modifications which cells present, and to describe the appearance of some of them when prepared for microscopical examination.

My illustrations are all taken from the common locust, and are selected from the results of a recent original investigation on the histological structure of that abundant pest. The work was undertaken at the desire of Dr. A. S. Packard, Jr., in connection with the more directly practical labors of the U. S. Entomological Commission, and it is to the kindness of Dr. Packard that I owe the opportunity of utilizing my observations for this article.

I will merely remind the reader that the anatomy of the locust may be most readily understood by saying that its body is formed by an outer wall, including the external crust and the underlying muscles, and an internal tube, the digestive canal, the diameter and course of which are very irregular, as is shown in Fig. 1 of the accompanying plate. Between the body walls and the alimentary canal there is a large cavity in which various internal organs, notably those of circulation, respiration, and reproduction are situated.

Now, all these parts are composed of minute cells, and the examination of almost any one of them will suffice to show cells that are very characteristic. Let us take for instance a male grasshopper. The sexes may be readily distinguished by the position of the claspers at the end of the abdomen, which is straight in the female, while in the male it is curled upwards, so that the end of the abdomen appears club-shaped and the claspers seem placed on the back.

Opening the insect along its back, and spreading out the sides so as to expose the internal organs, almost the first things that strike the eye are the numberless glistening silvery threads, the ramifications of the tracheal tubes. These must be torn asunder in order to lay bare the reproductive organs, which form a large mass overlying the stomach in the anterior part of the abdomen; trace these organs downwards, following them around the sides of the intestine to the ventral and posterior part of the abdomen, and there will be found numerous long *white* tubes; these are the

vesiculæ seminales, which open into the long ducts of the spermaries and end blindly. If one of these be isolated, and then colored with hæmatoxiline or carmine, and examined in a drop of glycerine with the microscope, its walls will exhibit a great many minute colored dots of oval shape; these are the so-called *nuclei* of the cells; it is evident that they form but a single layer, for in no part of the wall of the tube do they lie over one another. By looking carefully it is possible to distinguish a faint polygonal outline around each nucleus; these outlines correspond to the surfaces by which the cells abut against one another. Thus we learn at once that a cell is a very minute body with granular contents, and a distinctly differentiated central portion, the *nucleus*, and moreover that the cells are laid close against one another, and cemented together by thin intervening layers known as the *intercellular substance*. But every *vesicula* consists of a wider upper portion, which is usually found filled with spermatozoa in the mature animal, and the walls of which are composed almost entirely of the layer of cells just described; and a narrower portion enclosed in a sheath of muscular fibres. This difference can be most plainly recognized by preparing transverse sections, which may be made with a razor from tubes that have been hardened in alcohol. The operation has already been described in the NATURALIST for July, 1877, and to that the reader is referred. A section through the upper part is represented in Fig. 1. The single cells, each with its darkly stained and coarsely granular nucleus, lies close against its fellows. They are all of about the same height, and form a single continuous layer. Every layer of this kind that lines any cavity whatsoever is called an *epithelium*. A section through the lower segment of the *vesicula* presents quite another appearance, as is shown in Fig. 2. The epithelium, *Ep*, still lines the cavity, but the cells are very much smaller than in the upper part, though they form but a continuation of the same layer. From this we learn that cells vary greatly in size, but the limits are much further apart than is here indicated. Outside the epithelium is a very thick and powerful coat of muscular fibres, *Mu*, which

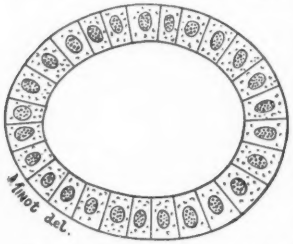

FIG. 1.—Section of upper part of Vesicula seminalis.

encircle the canal. Among the fibres occur elongated nuclei. Each muscular fibre in fact is a greatly elongated and peculiarly modified cell. But into this matter I cannot enter here; but I wish to point out that the lining membrane of the canals and ducts of animal bodies is generally if not always an epithelium, and that we frequently find the epithelium surrounded by a muscular coat. Thus may fundamental facts be observed on a single organ.

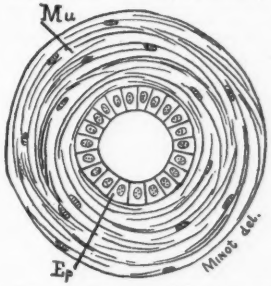

FIG. 2.—Section of lower part of Vesicula seminalis.

In the body of the locust there are long tubes, often pigmented, and opening into the digestive canal in the hind end of the stomach—they are the Malpighian vessels, so named after their illustrious discoverer. They make very beautiful preparations, if merely picked out, colored with carmine and mounted in glycerine, and are interesting to us because they have an epithelium which is very different from that above described. An optical section of part of one of them is represented on Plate II, Fig. 2. There is a very delicate external membrane which is hardly noticeable, though it forms a continuous external coating. Inside the epithelium is very distinct, but the cells which compose it instead of being high in proportion to their breadth are compressed; the nucleus is rounder, and the cell itself different from those of the seminal vesicle. The mass of matter which surrounds the nucleus is termed the protoplasm. Now, in the epithelium under examination the protoplasm of the cells is charged with coarse spherical granules. We naturally regard these peculiarities as somehow connected with the special function of these tubes, but in the majority of cases we are still unable to trace the relations of histological appearance to the physiological functions of organs. We have now made the acquaintance of a second kind of epithelium, and have learned to recognize cells by the presence of the nuclei, which, as far as we know, always have the property of being more darkly stained by various dyes than any other part of the cell. Moreover, each nucleus corresponds to a single cell, and there are never two nuclei in one cell. There are, however, some exceptions; thus the nervous cells (ganglia) of the sympathetic ganglia of vertebrates and of the

ureters of mammals (Englemann) frequently have two nuclei, and Dr. E. L. Mark, in his very valuable memoir on the *Coccidæ*, states that in the malpighian vessels of those insects he has likewise found cells with two nuclei.

The height of epithelial cells may be still further diminished, so that in some cases it may be said to have nearly disappeared, the cells assuming the form of a thin lamella. This is the case upon the air tubes. If one of these be colored and mounted in the usual way, the flattened epithelial cells may be easily recognized by their oval nuclei, Fig. 3 *b*. Each nucleus contains one or sometimes two minute spherical dots, eccentrically placed; these are the *nucleoli*. We have now seen the three constituent parts, which probably always enter into the composition of every cell; these are the protoplasm, the nucleus and the nucleolus. In addition we often find that the outside layer of the protoplasm becomes hardened and more resistent, and it is then called the membrane.

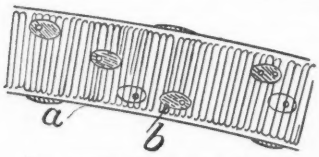

FIG. 3.—Small air tube from the abdomen.

In every epithelium we distinguish two kinds of surfaces on each cell, those which lie against other cells, and those which are free, facing the cavity. On the free surfaces the membrane is often considerably thickened, and the thickened portions are then so joined together that they form a continuous lamella, which is called a *cuticula*. Now the flat epithelium of the air tubes forms a very curious cuticula, which lines all the tracheæ, and is remarkable for being thickened in some places more than in others, thus developing a spiral thread, which can be seen in Fig. 3, underneath the nuclei. The spiral filament was observed very long ago, but its real nature was only recently discovered. For a more detailed account the reader is referred to the NATURALIST for July, 1877.

It is hoped that these illustrations will suffice to exemplify the more important features of epitheliums, tissues which are found in all animals except the protozoa, and represent one of the simplest and most frequent modes in which cells are aggregated. I propose to add a brief account of the structure of the digestive canal, in order to show some of the further modifications which epitheliums may undergo.

Fig. 1 of the plate represents a longitudinal section through a whole grasshopper, magnified three times. The cavity of the mouth, *M*, is not very large. The first segment of the digestive canal extends through the head and thorax, and is composed of two divisions, the narrow œsophagus, *Oe*, and the enormous crop, which is itself formed of two parts, an anterior, Cr^1, with transverse, and a posterior, Cr^2, with longitudinal ridges; this last terminates in a narrow portion, *P*, which corresponds to the proventriculus of other insects. This segment of the alimentary canal is especially characterized by its thick and hard cuticula, which almost completely obscures the underlying epithelium, outside of which, however, there is a powerful coat of muscular fibres of the kind called striated. The cuticula is thrown up into ridges and armed with fine but sharp spines that point backwards. The obvious function of these parts is to grind up the food: they are organs of mastication. The features in question are well shown in Fig. 4 of the plate, which represents a transverse section through the posterior part of the crop, magnified forty-five diameters. The ridges, *rid*, are small and numerous, and upon them can be seen the little spines, *s s*, and they are covered by the *cuticula*, which is very thick. The epithelium does not appear distinctly by this magnification, nor do the longitudinal muscles, *L*, but the transverse or circular muscles form a very thick layer, *muc. C.* Where the ridges are transverse, as in the front part of the crop and the œsophagus, we find the transverse muscles less developed and the longitudinal the most powerful.

The middle segment of the alimentary canal consists of the large ventricle, *ven*, known in German as the "*Chylusmagen*," with six blind sacks or diverticula appended to its anterior extremity; only one of these, however (*Div*), appears in the section Fig. 1. In this segment the cuticula is very delicate, but the epithelium undergoes another kind of modification, being thrown up into folds. In the diverticula there are twelve longitudinal folds, the structure and arrangement of which can best be seen in a transverse section colored with hæmatoxiline, Fig. 8, Plate II. The folds are high and thin, and covered by the epithelium, which is everywhere of about the same height. Outside there is a thin layer, *muc*, of muscular fibres, which do not enter into the composition of the folds. Between the muscles and the epithelium

there intervenes another kind of tissue, called *connective*, which also extends into the centre of each fold, separating the epithelium of the two sides. These three layers, the epithelium or *tunica mucosa*, the connective tissue or *tunica submucosa*, and the muscles or *tunica muscularis*, are the primary constituents of the digestive canal throughout the animal kingdom. It is always the epithelium which is the active agent of the secretion of the digestive juices as well as of the absorption of the food; hence it is important to make the surface of the epithelium which is to come in contact with the food as large as possible, and it is by the formation of folds of various shapes that this is accomplished.

The third and last segment of the alimentary tract consists of three divisions: first, the ileum, Plate , Fig. 1, which is as large in diameter as the stomach, for a part of which it was formerly mistaken; second, the very small colon, which bends forward and upwards (*col*), and opens dorsally into the larger and horizontal rectum, *R*. The whole of this segment is traversed by six longitudinal folds of the epithelium, which are broad with flat surfaces in both the ileum and rectum, but narrow and irregular in the intervening colon. Each of the six folds ends at the front end of the ileum in two rounded protuberances, making twelve in all. They have hitherto escaped notice. I propose for them the name of gastro-ileal valves. When viewed from their inner surface they have the appearance indicated by Fig. 7, being rounded in front and gradually fading out posteriorly. They are strongly pigmented. In transverse section, Fig. 10, we recognize the three characteristic layers, the epithelium which alone contains the pigment, the very distinct coat of connective tissue, and externally the muscular fibres. Examined with a higher power, Fig. 6, the epithelial cells will be found filled with round granules of various sizes of brownish color; which are the pigment; moreover, there is a thin but quite resistent cuticula armed with minute spines.

In the ileum we find the cells modified in still another way, as shown in Fig. 5, which is a surface view of part of the edge of one of the folds. The cells in the middle are quite large, but their size diminishes towards the edge, until at the edge itself they are comparatively diminutive. Fig. 9 is a transverse section through one of the furrows between two folds. *F* is the furrow; *Ep* the epithelium, the cells of which are smallest in the furrow. The epithelium rests upon a layer of connective tissue, *conn*,

which is separated from the muscular layer by a wide interspace, the muscular coat *muc. C* being attached to the connective only underneath the furrows, where there is also a single bend of longitudinal muscles, *L*, placed outside the transverse muscles.

Finally in the rectum, as shown in a transverse section, the epithelial cells are differentiated into two kinds, larger ones of the ordinary form, and smaller ones which lie higher up and present a circular outline. In vertebrates this differentiation of adjacent epithelial cells is carried to a great extent, and is especially connected with the development of glands; but the discussion of these is foreign to our present purpose.

In conclusion I will give a summary of our observations: Animals are built up of cells; each cell consists of a protoplasmatic body, a nucleus and a nucleolus; the cells are often grouped together so as to form a single continuous layer, which is called an epithelium; the free surface of such a layer is often covered by a thickened membrane, the cuticula, which is formed by the underlying cells. The cells of an epithelium may be modified, first as to size, second as to form, third, character of the cuticula, fourth, position, size, and shape of the nucleus and nucleolus, fifth, presence of granules or pigment, and sixth, differentiation of adjacent cells into two or more kinds. The epithelium may be modified by the formation of folds and pits of various forms.

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RAMBLES ROUND SAN FRANCISCO.

BY W. N. LOCKINGTON.

NO. I. THE OCEAN BEACH.

THE peninsula of San Francisco does not offer a very inviting field to the naturalist. A wilderness of rocky hills and sand-dunes, bearing no vegetation larger than a scrub oak, and swept by the winds and fogs of the great ocean, it lies, between the Pacific and the Bay of San Francisco, a bare and naked spot in the long wooded coast-line of California.

Yet, here as elsewhere, he who seeks with willing and educated eyes, will not fail to find much to interest him. The sand-dunes, the cliffs that border ocean and bay, and the rounded sandstone hills have each their special flora; many species of gulls, ducks and divers, herons, pelicans and cormorants visit the bay and the

marshes in the winter months; and the shores of the ocean and the bay, though poor in species compared with points either northward or southward along the coast, have each their characteristic forms of life.

Pleasant it is, when the clouds have rolled away, and the green hills and bay and ocean lie spread out before us in the glorious sunshine of a Californian spring morning, to leave the city's wooden sidewalks and ramble away to the ocean shore. On such a trip let us now start; let us feast, Barmecide fashion, on the good things of nature, bringing together, as those who feast in such fashion may, all the delicacies of the season to adorn our table.

In the centre of the peninsula, at some distance from any other hill, rises a conical elevation covered with loose sand and surmounted by a tall cross. Around it lie the cemeteries of the city, once far out of town but now becoming gradually surrounded by houses. Near the foot of this "Lone Mountain" we alight from the horse-car and strike out over the sand-hills toward the ocean, stopping, however, to pluck the flowers and to rummage among the old roots of the blue lupine (*Lupinus albifrons*) and the low bushes of groundsel-tree (*Baccharis consanguinea*) for the living treasures hidden there in the form of lizards and frogs which have not yet left their winter retreat. A pretty long-tailed black and white lizard (*Gerrhonotus multicarinatus* Blainv.) is our first prize, soon followed by a small tree frog (*Hyla regilla*). Another search brings to light a pair of "swifts," not birds but iguanine lizards (*Sceleporus undulatus* Harl.) and two or three more tree-frogs.

Our lizards are cold and sleepy, for the warmth of the sun has not yet penetrated to their place of concealment, but after a few minutes in our hands, exposed to the sun's rays, they became more lively, and ran off a short distance. The long slender Gerrhonotus, with his tail trailing along the ground, is strikingly different from the bluff-bodied conical-tailed Scelepori, with their rough-scaled gray backs lined with undulating short stripes of black, and displaying the bright blue of the sides of the abdomen.

Don't touch the Gerrhonotus incautiously when he gets lively, for if you catch him anywhere except just around the neck, he will surely either bite your finger sufficiently hard to make you

drop him, or he will drop off his own tail and leave you a spoiled specimen. The Scelepori are not so fond of throwing off their tails, nor nearly so apt to bite, but in summer time when they are active they are exceedingly hard to catch. They are not called swifts without reason.

What is the color of a tree-frog? Green for the most part, certainly, yet it varies greatly. The black marks upon the back are very distinct in some, quite faint in others, and one of our specimens is brownish, while another inclines to yellow. These fellows we have caught under the bushes are, in one sense, not so "green" as those we will find among the leaves at a more advanced season.

But our low bush furnishes us with insect as well as with reptile life. It literally swarms with "squash-bugs," big black millipedes (*Julus*) lie coiled among the decaying leaves, a long bright-red Scolopendra hurries away from our invading hand, and hunting spiders run to and fro in hot haste.

We are now on a rising ground at the edge of the Presidio reservation. Below us, in a little valley encircled by hills, lies a small fresh-water lake known as Mountain Lake, a line of shrubs beyond this marks the course of the stream which runs thence to the ocean, and the view is closed by the cliff-encircled bay outside the Golden Gate, forming the entrance to the harbor of San Francisco. Away on the farther side of the bay is the white lighthouse of Point Bonita, and oceanward a line of breakers marks the dreaded bar.

We hasten down to the lake, hoping to find there, as we have found before, numerous specimens of the fresh-water snails of the genera *Limnophysa*, *Physa* and *Helisoma*, as well as the tiny flat *Gyraulus vermicularis* Gld. But we have forgotten the thirty inches of rain that have fallen since we visited the spot in September last. The lake that was then so low that we could explore much of its bed, and so clear that we could see the bottom, is now a broad sheet of turbid water, in which the shell-fish are lost to sight. The spot where we picked up the flat-whorled Helisoma in shallow water, full of confervæ is now far from the shore, and the beach, once strewed with the shells of the fresh-water clam (*Anodonta wallamatensis*, sweet name this), is now lake bottom again.

The yellow water-lilies (*Nuphar advena*) whose tops and mas-

sive thick roots, marked, like the Sigillaria of the coal measures, with the scars of former leaves, which were in September either left high and dry, or in very shallow water, and from the under side of whose leaves we picked water-snails, together with a small crustacean (*Hyalella dentata* Smith), are now entirely covered by the water, and we can no longer grope our way among the long blades of the tule (*Scirpus lacustris*) sufficiently far to frighten out the grebes (*Podiceps californicus*) that make their home there. In revenge, we will gather flowers on our way to the ocean, and take notes on the vegetation of February. The blue nemophila (*N. insignis*), a garden favorite in England, abounds among the grass, the yellow sanicle (*Sanicula arctopoides*) is coming into flower, the blue lupine is budding, we pass a bush of the flowering currant (*Ribes sanguineum*) gay with its fragrant pink racemes, and the Californian poppy (*Eschscholtzia californica*) flaunts its yellow blossoms in the shelter of the bushes of *Rhamnus croceus*, whose blackberries are still abundant. The soft blackberries of the Rhamnus have each two large seeds, flat on one side, convex on the other, and not unlike a coffee-berry in shape; this resemblance has deceived many good people who know the roasted coffee-berry better than they do the coffee-plant, and has been the cause of oft-repeated stories in the Californian papers about the "Discovery of the coffee-plant in California."

The poisonous liliaceous plant, *Anticlea fremonti*, is thickly spread over the hillsides in many places, but its spikes of pale-yellow flowers do not attain half the height of their kindred on the eastern side of the bay. The common storks-bill, "alfileria" (*Erodium cicutarium*), is everywhere, and, in wet places, another introduced plant, *Cotula coronopifolia*, crowds out the natives. But we are now approaching the ocean, and it is low tide, so we must hurry on if we wish to gather from the rocks the chitons, limpets, barnacles and other marine forms. Among the sand-dunes, near high tide level, is a small pool of perfectly fresh water, overgrown with duckweed and the pretty *Azolla caroliniana*, which dots the pool with spots of brownish-red. Here we gather *Hyalella dentata* in abundance, and we know there are some fresh-water snails here also, but cannot stop to gather them. The shore, where we reach it, is sandy, but close by, to the left, commences the sinuous line of cliffs, enclosing several small coves, which terminates to the south-west of us at Point Lobos.

Below this line of cliffs lie detached masses of rocks of various sizes, and some of the smallest of these, near to us, are exposed at low tide sufficiently for our inspection.

Upon the farthest away and largest of these detached rocks (out of our sight now, hidden by the southern cape of the bay), is the home of the sea-lions; sea-wolves or *Lobos marinos* of the Spaniards. On our right the sandy shore continues for about three quarters of a mile, when the rocks again approach the sea, fringing it as far as Fort Point, where stands the brick fort built to defend the Golden Gate, but superseded now by extensive earth-works on the hills above. We can see also the fortifications of Lime Point, on the Marin county shore of the entrance to the harbor.

The rocks nearest the water are literally covered with stalked barnacles (*Pollicipes*) in bunches the size of the fist, and among them, conspicuous at a distance from their bright coloration, are groups of the common five-rayed starfish of the coast (*Asterias equalis* Stm). This stoutly-built starfish is remarkable from the fact that about half the individuals are of a bright purple tint, while the other half are an equally bright gamboge yellow. Out of several hundreds that I have seen, none were intermediate between these two types of color, and none, so far as I remember, showed spots or blotches of the two colors. Inside the harbor of San Francisco this starfish is abundant, and another species, *Asterias gigantea*, which attains a diameter of two feet, is also occasionally found, but I am not aware that the common pentagonal starfish of the coast, *Asteropsis imbricata*, has ever been taken within the heads, and the large twenty-armed *Pycnopodia helianthoides* does not occur so far south. On the rocks near Fort Point, adhering to the surface and of the same green tint with the seaweed around it, I have found a small Asteroid which I believe has not yet been scientifically described. It usually has six arms but some specimens have fewer, its surface is more even than that of *A. ochracea*, and in size it is a very dwarf, measuring about an inch across the arms.

But we must return to our examination of the rocks or the tide will soon bar our access to them. We secure several specimens of two species of chiton, *Mopalia hindsii* and *Katherina tunicata*, but it takes close looking to find them, as they lie close in crannies and among mussels and barnacles, and, moreover, are not

unlike the rock in color. In the last-named species the valves of the shell are almost entirely hidden by the thick mantle; nothing is visible but a row of little black bucklers along the median line of the animal.

The sculpturing of the surface of *Mopalia hindsii* is, like that of many of its relations, very delicate. Its nearest congener, *Mopalia muscosa*, and its gigantic relative, *Cryptochiton stelleri*, which when alive measures nearly a foot in length and is fully four inches wide, are not to be found on the peninsula of San Francisco, though they occur a few miles to the northward.

As we step upon the rocks we are saluted by numerous little jets of water, which take their origin from soft and seemingly shapeless masses beneath our feet. A more careful glance at these shows us that they are sea-anemones, for we catch sight of some that are partially expanded, and on searching a little farther we come upon a rock pool containing numerous individuals in a state of complete expansion. Beautiful objects they are, bright green tentacles on a bright green disc, and fully four inches across. It is curious that this large sea-anemone, together with two or three smaller species common in and around the Bay of San Francisco are still undescribed, unless they should prove identical with species described by Prof. Verrill from points northward or southward of our locality.

Two species of sponge gathered from the under sides of the rocks, some limpets (*Acmæa*), *Purpura saxicola*, *Chlorostoma funebrale*, and a small *Litorina* make up our total catch at this spot before the rising tide drives us back to the cliffs, where, in a recess damp with percolating water, we may capture four or five specimens of the rare Isopod, *Lygia dilatata* Stm. Everywhere upon the rocks, and in many places among the débris cast up by the tides, darting about swiftly in the sunshine and hiding in the crannies on our approach, we find its near relative *Lygia occidentalis* Dana; but *L. dilatata* is rare even in this locality, the only one in the neighborhood where I have met with it.

The stream running from Mountain Lake is made use of by the Spring Valley Water Co., and the flume conveying its water to San Francisco is carried along the face of the cliffs, bridging the ravines to Fort Point, and forms a convenient though narrow footpath. Along this route, a little later in the season, the sloping portions of the cliffs will be covered with the sweet-smelling wild

wall-flower, *Cheiranthus capitatus* Dougl., and the pretty red rock-cress, *Arabis blepharophylla*, but now, the rains just over, we only find green leaves.

In a hollow between the hills, where a tiny rillet is bordered with willows and dwarf shrubs of the blue ceanothus (*C. thyrsiflorus*), we see a flock of blue-birds, and pick up several red-bellied salamanders (*Diemyctylus torosus*) as they awkwardly sprawl among the wet herbage.

Descending to the beach at the fort we pick up among the débris cast up by the tide two species of those little jumping amphipodous crustaceans commonly called sand-hoppers, one kind (*Orchestia californiensis* Dana) is stoutly made, and is not found except near high tide level where it burrows in the sand in great numbers and hides beneath the wet débris; but the other species (*O. traskiana* St.) is more terrestrial in its habits, and may be found under heaps of dried grass and straw, dry horse-droppings, etc., at some distance from the beach.

On the under sides of the flat stones, wriggling along the wet surface and jumping actively when touched, we find a much smaller amphipod, less than half an inch in length, some of these we place in a bottle of sea-water, and on examination under the microscope at home are struck with the beautiful plumes of hairs which adorn the under side of the joints of the antennæ, and know that it is *Allorchestes plumulosus* Sb.

Along the edge of the rising tide we pick up two small jelly-fishes. They have little beauty and apparently little life when picked up, but after a few minutes in a large bottle of sea-water they begin to expand and contract their bells, a circlet of bright purple spots (ocelli) becomes conspicuous around the margin of the bell, and the tentacles all contracted when we pick them up, lengthen out until they reach from two to three times the height of the bell, which is about an inch. It is *Polyorchis penicillata* A. Agass., one of the loveliest of jelly-fishes. Large specimens of *Aurelia labiata*, a Discophorous medusa fully a foot across, with large purplish ovaries showing through the transparent bell, are floating upon the tide or stranded on the shore.

Leaving the shore we walk along the edge of a large pool in the salt-marsh between the Presidio and the sea; here a large flock of gulls is swimming; there are two species, one is the common yellow-billed *Larus occidentalis*, but the other, conspicuous from

the pure black and white of its plumage and its black bill, is *Chræcocephalus philadelphia* or Bonaparte's gull. The long slender bill and long pointed wings of this species give it a great resemblance to the terns, or sea-swallows, which it rivals in grace and beauty. From the farther end of the salt lake rises a beautiful large snowy-white bird, with long bill and lengthy legs trailing behind, this we believe to be *Herodias egretta* var. *californica* Baird. We watch its flight to the other end of the lake, where it alights and recommences its business of feeding on small crustacea, etc.

Evening is now closing in as we approach the cars at Harbor View, the little grebes scud homewards over the bay in squads of eight or ten, the brown pelicans flap heavily towards their roosting places, and the cormorants, one after the other, form a retreating line as they make off to their haunts on a more wooded part of the bay.

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PHOSPHORESCENT INSECTS. THEIR METAMORPHOSES.

BY MRS. V. O. KING.

ANIMAL metamorphosis is so uniform in its manifestations within certain limits, as to impart to its processes an apparent character of permanency. Whenever, therefore, we first observe any one of its phenomena which is beyond our experience, the curiosity is excited at what is rare, and we are led to inquire whether this new feature is anomalous, or whether it is not rather an exponent of capabilities hitherto dormant, but agreeably to law responding at the proper time to given conditions in the animal economy. The remarks of Mr. Wollaston, a few years since, on the relations existing between the apterous forms of insects and their atmospheric surroundings, and the further elaboration by Mr. Darwin of the method by which such results as the gradual modification of structures, etc., are attained, naturally occur to the student of these apterous phases of metamorphosis.

Among articulata representing the apterous types, there are probably no species more interesting than those embraced in the family of *Lampyridæ*, since they exhibit great diversity in their metamorphic traits. By their phosphorescent habit they enable

the inquirer to follow them throughout their developmental career to ultimate perfection in the imago; and in them also may be seen to commence anew the life cycle dating from the deposition of ova. This rare privilege of tracing insect metamorphosis is not afforded however, even under the most favorable circumstances, without great risk of self deception on the part of the investigator.

Of phosphorescent *Lampyridæ* in the south-western part of the Atlantic district I am acquainted with eight species; two of these have apterous females, which are also distinguished by other peculiarities. In this article I shall assume their origin from a common type, which by a series of progressive and retrograde steps have given rise to their present forms.

Buffon's assertion that "nothing in nature is so permanent as type," is well sustained in the known tendency of both plants and animals, when not influenced by extraneous causes, to return to an original model; while on the other hand this very inclination to resume a certain form implies a capability of change.

"Whenever," says Humboldt, "a new element develops itself in the feelings of mankind, it may almost invariably be traced to an earlier, deep-seated, latent germ." What this great writer said of the emotional nature, will probably apply with equal force to the development of physical structures and functions. The capability of adapting or evolving these is the "deep-seated, latent germ" which is a positive power residing in animal forms, only awaiting the given conditions of its action to produce apparent anomalies, and in some instances masked representatives of seemingly extinct races, constituting a reversion to their primitive type. This assumption of new powers is witnessed in the metamorphosis of any insect, and has led to a close scrutiny of life in its earlier or embryonic forms with a view to discover whether all the parts of the imago are present in the earlier period; many students of nature, perceiving the impossibility of effects without something more definite than a name for a cause, have thrown great light upon the subject.

Oken illustrates the gradual elevation in the scale of powers in the articulata by the metamorphosis of the *Lepidoptera*, which he says are born as worms, represent the crustacea in the pupa stage and finally attain true insect perfection in the imago.

Beginning at the lowest phase of animal perfection as assumed

in the apterous female of *Lampyris*, we may suppose this to be intermediate between the true larva and a higher form, the winged *Coleopteron*, of which latter Agassiz says, "they are scarcely more than worms, with certain structures and functions to suit their needs."

These aptera having a latent capability for higher development, in consequence of certain influences, differentiation begins, any apparent change having been preceded by imperceptible ones, such as the gradual concentration of nerves and muscular fibre in the wing-bearing segments. Rudimentary wings and elytra resulting from their fusion under constantly favoring circumstances, attain the maximum of their development in the hardier types of winged *Lampyridæ*. At a certain point we have male and female fireflies as the typically perfect insect.

Once having acquired wings an insect might by prolonged flight change its relations, and may thrive for a while in its new habitat. But either suddenly or by slow process its surroundings are changed. Climatic influences, after a time, test the powers of the winged articulate. Many insects may be presumed to perish, others modify their structures and functions, by non-use of some and development of others. By this course, which must be attended with great loss to individuals, incident to race preservation, some attain a degree of conservative perfection.

In some instances the more robust individuals which are able to contend successfully with the elements, like sturdy gymnasts who develop their muscles by muscular effort, gradually assume a still hardier habit, which is transmitted to their progeny in the larger and more powerful organs of flight, stronger manducatory organs and more fully developed eyes and feet. This evidently progressive phase may be coincident with apparently retrograde metamorphosis in some of the feebler members of the same family. The first tendency to degradation may be preceded by what is termed "an accident," a deformity occasioned by the insect's wings having been mutilated when rudely tossed against resisting objects by the winds. This peculiar feature appears in the offspring as an inherited shortening of the wings, it being well known that peculiarities acquired, or losses sustained, are not only transmissible to the progeny but frequently in an exaggerated form. The transition of an insect from an ærial life to that of an apterous creeper would, if gradual, be coincident with cor-

responding alterations in many of its parts in conformity with the new conditions of its existence. In accordance with the laws of adaptive evolution, large eyes, embracing great areas, either in pursuit or avoidance of rapidly-moving objects on the wing, being no longer of use in this degraded position, where they could neither aid the insect's flight nor assist it in procuring sustenance, would gradually be replaced by less globular ones with smaller lenses suited to nearer views. If this degradation were sudden it would be attended with great mortality; hence we find few beetles to be apterous, indicating, in my opinion, one of two probabilities, either that they are unable to sustain the rapidity of the change, or that being a comparatively recent evolution they have not yet attained numerical importance.

According to Mr. Felix Plateau, the centre of gravity differs in the larva and imago of insects, being effected by the coincident enlargement of the thoracic and the diminution of the abdominal segments. This fusion of segments and their ganglia, in view of the part they play in supplying the legs and wings with their suitable nerves of sensation and motion, having adapted the centre of gravity to given conditions, there would be a proper equipoise in all the parts. It can easily be seen that upon a change from the winged to the apterous type, if this were comparatively sudden, the body would be unwieldy, and the disproportion between the parts, rendering the creature's motions heavy, would tend to the non-use of the feet, and the consequent enfeebling of these members. Being unable to travel far in quest of food the insect would from necessity have less opportunity of feeding, thus aborting the manducatory organs from want of use. The chances of individual life being thus diminished the apterous female would no longer exist for herself but, supporting life from material probably stored up in the more active larval stage until she had deposited her eggs in a suitable nidus, would then expire, having completed her mission of race-preservation.

In thus treating of what might be expected from an insect having certain powers of adaptation, I have followed the order as indicated in the different characters seen in *Lampyris*. I have traced it in its supposed evolution from an apterous to that of an ærial being, and back to earth again as a creeper with heavy disproportioned body, feeble feet and mandibles, small eyes, and brilliant terminal segments.

As illustrating another phase of metamorphosis, I will mention a short-winged male which still retains the larger eyes and more brilliant pigment after they have probably ceased to be of service, pointing to its comparatively recent degradation, and illustrating what Dr. J. LeConte calls "a structure which has outlived its usefulness." The eyes are no doubt retained for awhile by inheritance, but we may safely conclude to be eventually modified.

The preceding remarks have applied only to structures and functions, but at each stage of change in these, corresponding variations have taken place in the coloring of different parts, from black to pale yellow.

In one species the strong-winged male is of a dirty brown, coarsely porous, and finely pubescent on the elytra. The apterous female is a pale buff, glabrous, concolorous; thus, in accordance with the laws appertaining to the different conditions, evolution was arrested in the apterous imago at the color series which belongs to the larva, apparently a simpler process than that which a change of color would imply. This possibility is intimated by Agassiz in his "classification upon embryological data" when he says that the beetle preserves the character of the larva of other insects, assuming only wings and more fully developed legs without reaching other successive metamorphoses. There are lesser stages as represented by the different species, enabling us to link the family in a successive chain from an original pair to this seemingly new creation. This is probably the resultant of an effort at race-preservation, a product of the wear and destruction of individuals into conditions which enable them to perpetuate their race until such time as shall favor their reversion to the original type. The more interesting phenomena of phosphorescence witnessed in this sub-family will be the subject of another article; and it may be proper here to remark, that the researches of the writer, both in the field and the laboratory, have been made, not with a view to fortifying any particular theory, but for the purpose of discovering truth as it is manifested in nature, and applying it to the ever-varying phenomena of insect life.

ON THE GENEALOGY OF PLANTS.

BY LESTER F. WARD, A. M.

ONE of the most remarkable anomalies, which the history of science and that of the human mind affords, is to be found in the appreciation which has been shown of the relationships which the different forms of life present. There has been no lack of acumen in discerning these relationships, in detecting the differences or recognizing the affinities, but there has been frequent failure to comprehend their meaning. The term relationship has been employed in a sort of metaphorical or metaphysical sense, as denoting mere resemblance wholly disconnected from any idea of natural dependence; as if the objects of nature were arbitrarily grouped into classes, orders and genera by the operation of some law of "pre-established harmony." It might be supposed that the term relationship, constantly in use in this sense, ought to have suggested the analogy to family, or *consanguineal* relationship among men, and led naturalists to seek to account for the resemblances observed among plants and animals on some such principle as that on which family resemblances are explained. Yet this simple deduction proved too profound for the human mind, and botanists and zoölogists went on accumulating facts down to the time of Lamarck, and most of them to that of Darwin, without perceiving their most obvious meaning. And there are still many who fail to perceive it, and who openly reject it when pointed out to them.

It is perhaps but proper to add that this state of things has not been wholly due to an inability to make rational deductions, but has been in part brought about by the existence of preconceived ideas which were sufficient to preclude all attempts to reason towards the true conclusion, however plain this course might appear to the unbiased mind.

But now that it is becoming generally recognized that the present forms of life are the true descendants of antecedent forms, and that the observed resemblances are the physical result of real or genetic relationship identical with that which makes children resemble their parents, it is but natural that old systems of classification should require to be entirely recast and moulded into harmony with this fundamental truth. Such, indeed, is the case, and already marked progress has been made, especially in zoölogy,

in which department chiefly, nearly all the most advanced workers in this field have concentrated their efforts.

In addition to other and greater benefits, this revolution has had the effect to relieve the systematists of the odium which naturally attaches to the apparently useless labor of classifying objects conceived as independent of one another. A dependence once established, classification becomes a vital process, and the only means of solving the highest of all scientific questions, that of the genesis of organic beings. Every fact in morphology or physiology, hitherto regarded too much as ends in themselves, now becomes an additional link in the chain of evidence which is to establish the genealogical history of a plant or an animal. Thus classification, formerly regarded as simply a means for the more convenient study of living things, becomes the highest object and chief end of biological investigation.

It is a matter of common remark that in the sudden advance of biological science which has taken place during the last eighteen years, it has been left for botany to bring up the rear. Prior to 1859 it was generally conceded that the science of plants occupied a considerably more advanced position than that of animals. This was due in the main to the impetus which it received at the hands of the Jussieus, who, following up the labors of Tournefort, had given to botany its so-called " Natural System."

But the Jussieus understood relationship only in the metaphorical sense, and maintained the fixity of species, and the system they established could not of course satisfy, in all respects, the law of genealogical descent. Its worst vice was the weighty authority which it acquired, and which became a serious barrier to its extension and rectification. But there are other reasons, existing in the nature of the two departments of biology, and which need not here be stated, that have contributed to permit our study of the vegetable kingdom to be outstripped by that of the animal kingdom. There has not, however, been wanting a deep sense of the inadequacy of the so-called Natural System of Plants, and in quite recent times its imperfections have become too obtrusive to be longer disregarded, even though greatly reduced by the labors of Lindley, DeCandolle, Hooker, Gray and others; and an effort has already been commenced, especially on the continent, to subject that system to a thorough criticism, with the aid of the new light which the modern school of biology has kindled in all its departments.

I do not propose in this paper either to review the literature of this subject, which is already becoming voluminous, or to attempt, among the many conflicting theories advanced, to reconstruct the natural system, but shall seek rather, in the light both of the new facts and the new principles already accepted, to state some of the objections to the received classification, and sketch, in its most general outlines, the form and direction which I conceive that the approaching reform is most likely to assume.

Probably the most objectionable feature of the system of classification proposed by Jussieu and still adhered to in nearly every systematic work on botany, is the position of the Gymnosperms. These constitute a sub-class of the Exogens and are made co-ordinate with the sub-class Angiosperms, which only embraces the Dicotyledons proper, or true flowering Exogens.

This arrangement and terminology involves a number of grave inconsistencies. In the first place the so-called Endogens or monocotyledonous plants are as truly Angiosperms as are the plants to which that term has been thus specially applied, the pistil consisting in both cases of a closed ovary. The Gymnosperms, therefore, in the present system are placed between the two great divisions of the Angiosperms and made to interrupt the natural series. The most casual observation, both of the foliage and the flowers, shows how awkward this position is, and indicates without closer scrutiny, that the Gymnosperms are out of place. Moreover, the enclosure of the germ is what chiefly distinguishes the phænogamic from the cryptogamic series, and the degree to which this is accomplished should mark the degree of advancement from the cryptogamic state. But we shall presently look deeper into this phase of the question.

In the second place, the reason assigned for the position of the Gymnosperms is the exogenous structure of their woody tissue. This argument might have some force if only the *Coniferæ* were embraced in the sub-class; but when we consider the *Cycadaceæ*, which equally belong there, a difficulty arises. Here the woody tissue assimilates almost altogether that of the endogenous palms or cryptogamic tree-ferns.

Again, the wood of the *Coniferæ* is by no means identical with that of the true Dicotyledons. It is destitute of the continuous vessels called ducts with their minutely porous joints, so characteristic of the former. The secondary wood consists, with the

exception of the medullary rays, entirely of large tubes, called *tracheïdes*, occupied with large prosenchymatous cells, which latter are nearly of uniform shape, while in the true Dicotyledons the tissue is in part parenchymous and the cells much more numerous and varied in form; moreover, the small circular areas enclosed between the walls of adjacent cells or *tracheïdes* are much more numerous and pronounced, especially in old tissue, in the *Coniferæ* than in the Exogens proper.

There is still a third important respect in which the Gymnosperms differ from the remaining Exogens in a marked manner. This is in the number of cotyledons, which is here usually more than two and sometimes as many as fifteen, while in true dicotyledonous plants the number is uniformly two; only a very few exceptions having ever yet been found; as, for example, in *Ranunculus ficaria*, which usually has but one, and in some species of *Phaseolus*, which sometimes have a whorl of three.

The objections above enumerated to the position of the *Gymnospermæ* in the prevailing system are quite independent of any recent facts pointing to their origin and derivation, and would be equally applicable under the old metaphorical conception of relationship. It is, therefore, all the more strange that it should have survived so long and should have required the argument from descent to finally break it down.

Evidence of this nature, however, is not now wanting, and it very plainly points to the direct *filiation* of the Gymnosperms upon the Cryptogams. This evidence concerns two important sets of characters, the woody tissue and the reproductive organs. As regards the former the close resemblance of the *Cycadaceæ* to the arborescent ferns is very obvious from a glance at a cross section of each. If this character, therefore, possessed the importance which is claimed for it, it would be found more difficult to pass from the *Cycadaceæ* to the *Coniferæ* than from the latter to the Dicotyledons. And we shall hereafter see that great liberty has been taken in thus grouping the *Cycadaceæ* and *Coniferæ* together.

If we consider the *Coniferæ* alone there is one class of facts recently brought to light which possesses an unusual interest. The investigations of Prof. Williamson[1] have shown that the trunks of *Lepidodendron*, exhumed from the coal beds of England,

[1] On the Organization of the fossil plants of the coal measures. Phil. Trans., 1872.

exhibit a species of exogenous growth. This differs not only from that of the existing pines and from that of the true Exogens, but also from that now known to take place in certain monocotyledonous plants and constitutes a sort of fourth type. It consists, so far as understood, in the formation of a layer of growing tissue with dividing cells (*meristem*) around each fibro-vascular bundle, the continuous division of whose cells necessitates a radial or centrifugal increase of the entire stem. A similar structure on a small scale occurs in certain now living cryptogamic forms, as in *Botrychium*, *Isoëtes*, etc. This form of exogenous growth may perhaps be regarded as marking a transition from the endogenous structure of most cryptogamic stems to the form of exogenous structure which prevails in the *Coniferæ*, but which has not been transmitted to the branch from which, on the hypothesis of descent, the *Cycadaceæ* have been developed.

The transition in the reproductive system is far more obvious and remarkable. What is known as "alternate generation," so long familiar to zoölogists, is now found to prevail throughout the greater part of the vegetable kingdom. It is most apparent in the higher Cryptogams, especially in the mosses, ferns, *Equisetaceæ* and *Lycopodiaceæ*. In all these the final stage is the production of a plant or "generation" capable of developing spores, which are of both sexes, and produce the sexual plant. Among the vascular Cryptogams there are two orders, one the *Rhizocarpeæ* in the fern group, the other the *Ligulatæ* in the club-moss group, in which the final spore-bearing stage is sexually differentiated. These produce two kinds of spores, called respectively, from their relative size, *macrospores* and *microspores*, the former of which develops a female, and the latter a male *prothallium*, or sexual plant. This *prothallium*, which in most vascular Cryptogams is an object of considerable size, and which corresponds to the entire leafy portion of the mosses, liverworts and other cellular forms, continues to diminish as the degree of organization increases; the spore-bearing generation, on the contrary, increasing in a corresponding ratio; the large fronds of a fern representing only the seta and capsule, or fruiting portion of a moss. In the *Rhizocarpeæ* and *Ligulatæ*, whose macrospores and microspores indicate a higher organization, this reduction of the sexual generation is carried so far that the *prothallium* scarcely protrudes from the spore, or is wholly confined within it. Hoffmeister[1] has

[1] Vergleichende Untersuchungen, 1851.

long ago pointed out the true significance of these facts, and shown that we have only to continue this same process a step beyond what it has already reached in *Salvinia* and *Isoëtes* to arrive at the condition presented by the existing Gymnosperms, the *Cycadeceæ* and *Coniferæ*. Here the macrospore exists under the name of embryo-sack, while the microspores are the pollen-grains. The so-called *macrosporangia* of these highest Cryptogams thus correspond to the ovules[1] of the Phanerogams, while the anther-cells of these latter are homologous with the *microsporangia* of the former. The *prothallium* is readily traced to the Gymnosperms, especially in the fertile flowers, where it re-appears under the name *endosperm*, and constitutes the albumen or reserve material of the future seed — one of the finest examples in biology of the fundamental identity of the reproductive and nutritive functions. In the staminate flowers the *prothallium* may be considered as represented by the *pollen-tube* (the elongated cell that descends from the pollen grains into the ovary and fertilized the germ), although a careful study of the microspores of *Isoëtes*, in which one cell remains sterile while the rest develop the *spermatozoa*, may leave some doubt as to whether the homology is here quite complete. The greatest differentiation has gone on in the microspores; the microspores and the plants and organs bearing them, still presenting, in many cases, a striking resemblance. In the *Cycadaceæ*, for example, the anther-cells are sessile and single or in groups upon the lower surface of the broad filaments like the "fruit dots" on the back of a fern. In the *Coniferæ* the stamens are less leaf-like, but the pollen-sacks are often solitary and scattered over the under surface of the flattened filaments.

An interesting similarity also exists between the male aments of certain *Taxaceæ*, as in the yew and the juniper, and the spikes of *Equisetum*, the horse-tail or scouring-rush. In these cases it is said that nearly all the morphological homologies are satisfied.

In general it may be said that in all these respects the *Cycadaceæ* resemble most the group of true ferns, the *Coniferæ* proper (pines, firs, etc.), most the club-moss group (Dichotomes), and the

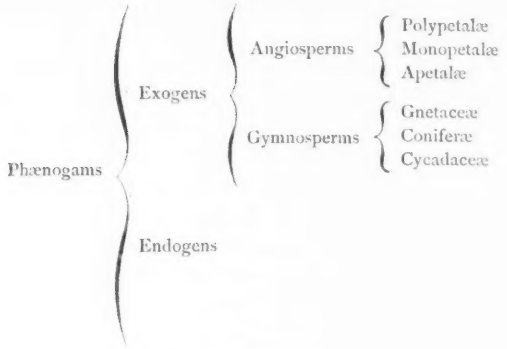
[1] Sachs (Yahrbuch der Botanick, 4 Aufl. S. 481) justly objects to the term ovule (or little egg) as entirely misleading in its etymology, and as tending to perpetuate the error that gave rise to its use, and proposes the term seed-bud (Samenknospe) as a substitute.

Taxaceæ, most the *Equisetaceæ;* a fact of great importance for the genealogy of plants, and to which we shall have occasion to refer again.

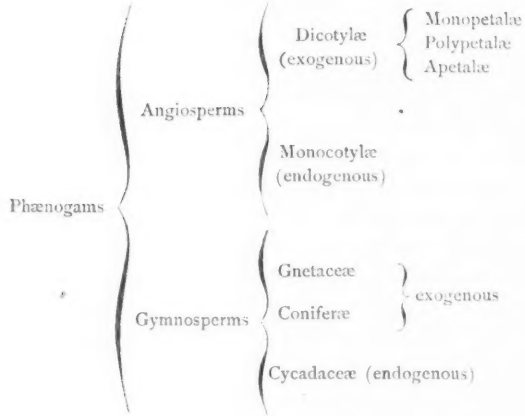
Upon the whole, therefore, it seems to be no longer open to serious doubt that both of these widely dissimilar orders of the *Gymnospermæ* (*Coniferæ* and *Cycadaceæ*), as also probably the *Gnetaceæ*, have been directly developed out of lower forms of cryptogamic vegetation. They should, therefore, certainly occupy a position at the base of the phænogamic series. Whatever may be ultimately accepted as the mode of transition from the Gymnosperms to the Angiosperms, it seems to be established that the former have actually descended from the latter, and they should therefore be all assigned a higher place in the scale of organization.

It is one of the misfortunes of botanical science that above the cellular plants no classification based on histological structure can be made; so nearly identical are the forms of structure through which all classes of vegetation pass. It is therefore necessary to depend in the main upon differences of the reproductive system, as affording the best characters by means of which to trace the development of vegetable forms. The Gymnosperms, no less than the Angiosperms, have both classes of structure, and we may almost say the same for the Cryptogams. But from the Cryptogam to the Gymnosperm, and from this to the Angiosperm, there is a continuous advance in one direction toward the complete protection of the germ as it is accomplished by the perfect ovary. It is indispensable, therefore, that all plants possessing this important character should be erected into one great group or class, and that from this group all plants to which this character does not belong be rigidly excluded. The terms *endogenous* and *exogenous* being common to both Angiosperms and Gymnosperms, should be excluded from the classification, or only employed to mark the subordinate divisions. The two systems of classification for the phænogamic series may therefore be thus compared:

OLD SYSTEM.



NEW SYSTEM.



The terms *Monocotylæ* and *Dicotylæ* are preferable to *Endogen* and *Exogen*, for the Angiosperms, since they lead to no confusion with the class *Gymnospermæ*. In this classification the terms conform to the strict rules for definition, each being wholly exclusive of all the rest. The reason for transposing the *Polypetalæ* and *Monopetalæ* will be given in another paper.

Before proceeding to consider more especially the manner in which the Angiosperms may have been derived from the Gymnosperms, it will be necessary to glance once more at the nature of the cryptogamic vegetation from which we suppose the latter to have descended. And for our purpose we may conveniently divide it into three groups: 1st, the group of true ferns; 2d, the

group of the club-mosses; and 3d, the horse tail group, or *Equisetaceæ*. The first of these groups seems to have come down to us from the Carboniferous epoch almost in an unchanged condition, trunks of tree-ferns quite similar to those still found growing in tropical countries having been exhumed from the coal measures. The second group must be made to embrace the ancient *Lepidodendron*, which flourished so abundantly in that luxuriant age, and whose resemblance to both our club-mosses, and to the proper Conifers has been so frequently remarked. In this group, therefore, there must have been great degeneracy, as of it the forests of that period seem to have been chiefly composed, while nothing now remains but the low herbaceous and moss-like plants that form our *Lycopodiaceæ*.[1] To the third group belonged the famous Calamites of the coal beds, and these too have dwindled into insignificant rushes.

Such is in fact the fundamental division of the cryptogamic series, and is based as well upon differences of internal constitution as of external aspect. If we associate these three classes of Cryptogams, respectively, with the three orders of the Gymnosperms, *Cycadaceæ*, *Coniferæ* and *Gnetaceæ*, we shall be able to discern many remarkable resemblances which, while they may really signify nothing, are sufficient at least to suggest an hypothesis. In the first group, or that of the true ferns, we have in the existing *Rhizocarpeæ*, to which our *Azolla* belongs, and of which the genera *Salvinia*, *Marsilia*, and *Pilularia* have been carefully studied, an undoubted transition towards the general condition presented by the *Cycadaceæ*. It is not unfavorable to this theory of transition that the existing forms indicating it are small and humble plants. The slight differentiation of the sexless spore into the macrospore and microspore could of itself have scarcely given the new form a special hold upon its environment, and we may almost wonder that this intermediary stage should not have succumbed altogether, as all the later ones probably have done. But the true phænogamic or flowering state once reached, permanence was acquired, and with it the power of attaining a higher development. It is remarkable that this differentiation affected the reproductive system only, and has left the woody tissue and also the foliage of the fern and the Cycad to a great extent unchanged.

[1] In the Sunda Islands there is a Lycopod that attains a diameter of six inches and a height of twenty-five feet.

That the *Coniferæ* proper (*Abietineæ*) have descended from the second or club-moss group, seems even better established than that the Cycads have sprung from the ferns.

The affinities of the extinct *Lepidodendron* with this group have always been recognized. Those who claim for *Lepidodendron* a Coniferous character only strengthen this view by showing how closely the two groups approached each other in those ancient times. The Araucarian pine of the southern hemisphere is even now covered with scales over its entire surface, and presents no small analogy with the *Lycopodiaceæ* and with what is known to have been the character of *Lepidodendron*. We must, therefore, regard *Araucaria* as our nearest living representative of the early transition form through which the Pine family was derived from the Carboniferous Lepidophytes. And it is especially interesting to remark that it is just this Araucarian group of true Conifers which we find associated with the arborescent cryptogamic vegetation, and whose scaly trunks lie side by side with the equally scaly trunks of *Lepidodendron* in the coal formation—a fact which shows at how early a period the differentiation began, and how little progress has been made within the same group during subsequent geologic ages.

With regard to the great advance which must have been made in passing from the crytogamic to the gymnospermous reproductive system, the evidence has already been briefly referred to. To the *Rhizocarpeæ* in the fern group correspond the *Ligulatæ* in the club-moss group, in which the asexual spore is completely differentiated into the sexual macrospore and microspore. In this order the only two genera thus far known, *Isoëtes* and *Selaginella*, have been faithfully studied by the foremost botanists of Europe, and the facts repeatedly verified. Hoffmeister's generalization, which is of the highest importance and has been generally accepted, has already been adduced, and its direct bearing on the immediate question need scarcely be reaffirmed.

The origin of the *Gnetaceæ* is far more obscure, and indeed so few positive facts have been brought forward to establish it that all speculation may be pronounced idle. That there is considerable general resemblance between the genus *Ephedra* and certain branching species of *Equisetum*, cannot be denied, but this similarity of habit is not accompanied by any corresponding similarity of structure either in the tissue or in the fruiting apparatus, while

the few genera which have been grouped under this order vary enormously in everything but their mode of inflorescence. Whether they have been developed independently from the Cryptogams or have been off-shoots from lower Gymnosperms must therefore remain one of the problems of botanical science; but it is a problem, as we shall presently see, which derives its great importance from the special *rôle* which the *Gnetaceæ* have been made to play, as a connecting link between the Gymnosperms and the Dicotyledons.

The highest marks of organization in the vegetable kingdom are the exogenous structure and the encasement of the germ. These may be regarded as the two great ends towards which vegetal life is perpetually striving. One of these ends is attained by the *Monocotylæ* or endogenous Angiosperms; both of them have been secured in the *Dicotylæ* or exogenous Angiosperms.

Although most of the intermediate stages, from the naked-seeded Cycad to the closed ovary of the Monocotyledon, have been obliterated, or have not been discovered, the evidence is nevertheless abundant that such a transition has taken place. If we consider what may be called their *physiognomy* alone, the descent of the true palm from the sago-palm, or both from a common ancestor in the *Cycadaceæ* would seem in a high degree probable. The great divergence in the matter of floral envelopes may be accounted for on the supposition that the differentiation, as is known to be frequently the case, was chiefly confined to the reproductive system and only slightly affected other characters. The absence of intermediate stages in our existing flora could then be explained by the now well understood law of the ephemeral nature of transition forms. In fact the Cycad is itself a transition form connecting the Cryptogams with the true flowering plants, or Angiosperms, and as such it is doubtless a comparatively ephemeral state. So far as general aspect or physiognomy is concerned, the ordinary observer, without trained scientific insight, naturally and instinctively classes the palm, the sago-palm, and the tree-fern in one and the same group, little imagining that botanists class them each in such a widely different group. Language itself builds on so obvious a resemblance. What we call the sago-palm, connecting it with the higher type, the Germans call the palm-fern (*Palmfarn*), connecting it with both the higher and the lower types of vegetation. Should further study

of these forms, in the light of the broadest principles of classification, lead the technical botanist to a recognition of their genetic relationship, and thus bridge over the two great chasms in the vegetable series, it would not be the first time that vulgar observation has been found to accord with true science after a long period of unmerited disdain.

The fact that the leaves of the *Cycadaceæ* grow from a terminal bud like the palms, while they unfold from the circinate apex like the ferns, shows that this resemblance to both palms and ferns is not altogether fanciful or purely superficial; in fact their genetic development from the latter, as already shown, is established by other evidence of the most vital character based on the morphology of the reproductive organs. It is therefore probable that the *Cycadaceæ* are not only more nearly related both to the *Palmaceæ* and the *Filices* than is generally supposed, but that they are less nearly related to the *Coniferæ* than is implied by their position in the received system of classification.

The wood of the *Cycadaceæ*, as already stated, consists of a mass of sheathed fibres in a large central pith composed chiefly of large prosenchymatous cells, and if not identical with that of the palms and arborescent ferns, certainly resembles this far more closely than it does that of the exogenous Gymnosperms. The similarity in the mode of flowering without which such a position could never have been thought of, may perhaps have been accidental, the two widely divergent lines of vegetation passing through some of the same transition stages in their progress towards the ideal type of vegetal perfection. The evidence already adduced of the derivation of the *Coniferæ* from a distinct stock of Cryptogams, to which the *Lepidodendron* belonged, would seem to corroborate this view, and this quite independently of the real origin of the *Dicotylæ*. Nor should botanists despair of still finding plain traces, in the transformations of the floral organs, of the descent of the *Monocotylæ* from the *Cycadaceæ*, and with this view the embryological study of the *Palmaceæ* cannot be too strongly urged.

The proper origin of the *Dicotylæ*, notwithstanding their possession of a closed ovary in common with the *Monocotylæ*, is a problem which presents the gravest difficulties to the genealogical systematist. Their derivation from the latter, though not wholly without legitimate evidence, is far from established, and may have to be altogether abandoned. The facts which support this hypothesis may be thus briefly summed up:

The endogenous structure of monoctyledonous stems is of two classes. In the palms, as in the *Cycadaceæ* and arborescent ferns, the foliage springs from one terminal bud which attains its full development before expansion, after which no further lateral enlargement of the stem takes place. This may be regarded as the normal form of endogenous growth. But another form is found in the trunks of the arborescent *Liliaceæ*, as in *Dracena*, *Yucca*, *Aloë*, etc., which may be regarded as representing an advance in the direction of an exogenous structure. The stems of these tree-like *Liliaceæ* actually undergo increase in size, or radial growth, after emerging from the bud. This takes place by the formation of a growing tissue (*meristem*) within the outer bark at certain distances below the terminal bud, which increases in thickness for some time before passing into permanent tissue, and effects an enlargement of the stem on all sides. A cross section of one of these trunks reveals a number of rings of this modified tissue, some of which are far internal, though at the time of their formation they must have formed the inner bark of the tree.

Although this is clearly an advance towards the true exogenous structure, it seems to be rather by way of analogy than of direct progress, the same end (power of strengthening the trunk to resist the force of gravity and of the elements and thus to render greater size and longevity possible) being attained, but by the adoption of a somewhat different means.

There is another group of plants, wholly different from those just described, which also afford considerable evidence of forming a transition stage from the endogenous to the exogenous structure. These are the aquatic plants. Sanio observes that in *Potamogeton* and other aquatic and submersed Endogens, "an axial bundle extends continuously through the stem, the bundles from the leaves only subsequently uniting with it," "a condition," says Sachs, "quite anomalous in monocotyledonous plants, but also found in dicotyledonous water plants, particularly in the *Nymphæaceæ*." Such a condition found among aquatic plants is certainly very interesting in view of the probable aquatic character of all primordial vegetation, but whether these facts possess any real significance in connection with the question of the origin of the Dicotyledons still remains doubtful.

In the venation of leaves of monocotyledonous plants, which is usually parallel, there are to be observed marked approaches

towards the reticulated structure which prevails with the *Dicotylæ*. Every one is familiar with many cases of this kind, as in *Dioscorea*, *Goodyera*, etc., while on the other hand, approaches to the parallel venation sometimes occur in the *Dicotylæ* (*Plantago*, etc.).

A far greater difficulty is presented by the cotyledons; for while there are a few cases in which exogenous plants develop but a single cotyledon, I am aware of no case in which an endogenous Angiosperm has been found to develop more than one. It is, however, presumable that a more complete investigation of this question may reveal transition forms here as elsewhere.

Such are the principal facts thus far made known which tend to encourage the hope of ever tracing the higher class of Angiosperms back to an origin within the lower class.

Far more satisfactory is the evidence that the Dicotyledons have been developed out of the *Gnetaceæ* and perhaps indirectly out of the *Coniferæ*. The *Gnetaceæ*, a small but interesting family of only three known genera (*Gnetum*, *Ephedra*, and *Welwitschia*) possess all the marks of forming a true intermediate link. The flowers of both sexes are provided with a sort of half-envelope, called the *perigonium*, which surrounds and protects the anther-bearing filament in the male, and the solitary ovule in the female flower, and may be regarded either as a rudimentary ovary or as a rudimentary perianth.

It is worth remarking here that the chasm between the Gymnosperms and Angiosperms is at all points greater with respect to the floral envelopes (including the ovarian) than with respect to the process and true organs of fertilization. The ovary of the Angiosperm is enclosed in an envelope, in the true Gymnosperm it exists but is exposed, in the *Gnetaceæ* it is half enclosed and half exposed. It matters not whether the *perigonium* be regarded as the homologue of the ovarian envelope or of the outer floral envelopes of the Angiosperms, since all the floral organs, including even the essential ones (stamens, pistils, etc.) are simply modified leaves. In the passage from the *Cycadaceæ* to the *Palmaceæ* no such connecting link has yet been discovered, and for the truth of such a transition we must rely upon the remarkably strong physiognomic resemblance coupled with the evidence furnished by the structure of the tissues and the mode of æstivation. The *Gnetaceæ*, however, while they give us this invincible evi-

dence of a transition in the rudimentary ovary, would seem at first view to afford no physiognomic mark to indicate the point at which the chasm was bridged over. There is one family of Dicotyledons, however, which, though little familiar to the inhabitants of the northern hemisphere, are none the less likely to have completed this transition, and in which there certainly is a strong physiognomic resemblance to at least one genus of the *Gnetaceæ*. Humboldt,[1] speaking of the remarkable form of the *Casuarineæ* of the East Indies, describes them as "trees with equisetum-like branches," and remarks that "Plumier's *Equisetum altissimum*, and Forskal's *Ephedra aphylla* of North Africa, are forms nearly allied to *Casuarina*." This physiognomic resemblance of *Ephedra* to both *Casuarina* and *Equisetum* is certainly very interesting, not only as affording a provisional hypothesis for explaining the transition from the Gymnosperms to the *Dicotylæ*, but also as marking out a line of investigation with a view to determining the origin of the *Gnetaceæ*. But to this we shall revert.

Not only do the *Gnetaceæ* thus approach the *Dicotylæ* in their reproductive system, but they also present a corresponding advance in the formation of the secondary wood from the structure of the *Coniferæ* towards that of the true Exogens. Besides the *trachëides* of the former it also contains vessels closely resembling the porous ducts of the latter.

Should the descent of the *Dicotylæ* from the *Gnetaceæ* be accepted as probable, it would only remain to determine the origin of the latter in order to complete a rough outline of the entire genealogy of vascular plants.

As already remarked, the attempt to affiliate them upon the *Equisetaceæ*, as a third independent branch of the Cryptogams, cannot be seriously made in the present state of science, notwithstanding the singular harmony in the general aspect of *Ephedra* and *Equisetum*. The fact heretofore pointed out, however, that a striking analogy subsists between the spikes of *Equisetum* and the male aments of *Taxus* and other allied genera, may be taken as a faint indication of what may have been the mode of development of these forms. It should at least be remarked that within the *Coniferæ* there is exhibited no small degree of progress towards certain leading characteristics possessed by the Dicotyledons. From the lowest to the highest,

[1] Ansichten der Natur, Stuttgart, 1871, p. 187.

from the Araucarian pines to the yew trees, such progress is well marked, and in *Salisburya*, the Japanese Ginkgo, which is related to the yew, the foliage comes at length to closely resemble that of many exogenous Angiosperms. The suspicion has even been expressed that all the genera of the *Coniferæ* may not have sprung from the same parent stock.

The origin of the *Dicotylæ*, which constitutes the chief problem in the genealogy of plants, is thus seen to be one which, while it admits of several possible solutions, nevertheless, in the present state of science, certainly admits of no positive solution. Whatever hypothesis we adopt, if we suppose a *monophyletic* origin for all plants, the derivation of both branches of the *Angiospermæ* from this common root will involve what may be thought to be a violent assumption. If the endogenous Angiosperms have developed out of the *Cycadaceæ* and the exogenous Angiosperms out of the *Gnetaceæ*, it requires some stretch of our credulity, in view of the bad repute into which all alleged "analogous" organs have in recent times fallen, to admit that the closed ovary, so identical in the two classes of plants, could have been arrived at from two such independent sources. To avoid this difficulty, which no one knows better how to appreciate, Prof. Hæckel suggests the probability that the Angiosperms as a class were first developed from the *Gnetaceæ*, and that subsequently they subdivided into the monocotyledonous and the dicotyledonous branches.[1] But with due deference to so high an authority, it is submitted that this would involve a still more violent assumption, viz: that an endogenous structure was derived from an exogenous one. Besides, we fail to find a single fact either in morphology or in palæontology to support this hypothesis. Again, if we seek to trace the genealogy of the *Dicotylæ* back through the *Monocotylæ* to the *Cycadaceæ*, we are driven to the equally forbidden presumption that the exogenous structure of the *Dicotylæ* and of the *Coniferæ* and *Gnetaceæ* was independently reached. There is, therefore, no serial line by following which all these difficulties can be escaped.

Those to whom all these instances of so-called "teleology" present no serious obstacle, may even find satisfaction in the conception that not only are the *Coniferæ* descended from two different parent stocks and the *Gnetaceæ* from still a third, but

[1] Schöpfungsgeschichte, Aufl. 5, Berlin, 1874, S. 430.

that the *Dicotylæ* may themselves be of heterogeneous origin, part of them being descendants of the *Coniferæ*, part, of the *Gnetaceæ*, and part, of the *Monocotylæ*. Should it ever become generally believed that the *Dicotylæ* are of multiple origin, the interest, now so great, in the true arrangement of the families of this class of plants would be greatly increased, and more satisfactory answers to many puzzling questions might be expected.

Perhaps the least objectionable of all the theories advanced, as that which requires the least extreme or improbable assumptions, and affords the greatest relief from the dilemma, is that which maintains the two great co-ordinate branches or parallel ascending series of the vegetable kingdom intact and independent from the most remote period to which they are traceable in the past history of the globe, and sees in the development of the endogenous and exogenous Angiosperms at the summit of each, respectively, the simple attainment in both of one of the great ends of vegetable existence, without which the highest functions of plant life cannot be manifested.

If we believe in the evolution of organic forms at all, we must accept that of vegetable forms, and if we are convinced that the higher plants are the descendants of lower ones, we ought by this time to have at least some provisional hypothesis as to the way in which this process of evolution has been going on in the vegetable world. We should not go on accumulating facts forever without attempting to make any use of them. In this age, when the law of descent has reached, in zoölogy, its exact stage, the stage of prevision and prediction, it is certainly time that some of the operations of this law were recognized and studied in the cognate kingdom of plants. The utmost that can be objected to any present attempt to trace the genealogy of plants, is, that the precise truth has not been reached, and those who are really competent to raise this objection must be competent to present a nearer approximation to the truth, which is the very service which science most needs. It is, therefore, with a full sense of the imperfection and inherent objectionableness of the scheme, and an entire willingness to see it superseded by one which shall better satisfy all the facts of science, that the one here rudely sketched is submitted. Stripped of all its complicating conditions and qualifications, many of which have been referred to and explained, this scheme of genealogy

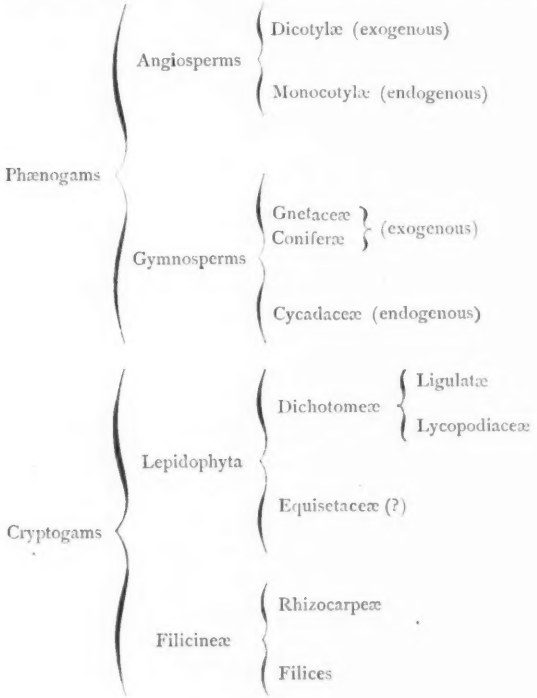
may be more clearly presented by means of the following rough diagram, in which not only are all additional coördinate branches left unrepresented, but the continuation of each stage beyond the point of divergence is, for the sake of perspicuity, removed, leaving the differentiations only to stand in naked outline. This diagram presents the two great lines of descent, that of the Lepidophytes, of which we have the fossil genus *Lepidodendron* in the Carboniferous, and that of the ferns, trunks of whose arborescent forms are also found in the same formation. The line of the *Equisetaceæ* is omitted, although it probably had an independent existence, and may yet be found to have a genectic connection with some of the higher types.

The order of succession here laid down is confirmed by what is known respecting the time at which each of the several groups first appeared in the geological history of the globe. The primary divergence must have taken place in the latter part of the Devonian age, since within this formation occur some remains of *Lepidodendron*, while fossil trunks both of this and of true tree-ferns are found throughout the Carboniferous strata. It was in this latter epoch that both the ferns and the Dichotomes or Lycopodites attained their greatest perfection and abundance. Whether any of the large trees belonging to either of these groups had advanced to the stage now represented by the *Ligulatæ* and *Rhizocarpeæ*, there is no means of knowing, but that this stage was reached in both the great lines during the Carboniferous epoch must follow from our hypothesis, since it is within this epoch that both the *Coniferæ* and the *Cycadaceæ* first made their appearance, and during which they attained to very much the proportions and general character which certain forms of them still present. These forms advanced at a parallel rate and both reached the point of greatest development and supremacy at about the same time in the Triassic and Jurassic periods. They are both at the present time clearly on the decline, especially the *Cycadaceæ*, which are on the open road to early extinction before the march of higher types of vegetation. The palæontology of the *Gnetaceæ* is little known, but they have been supposed to have originated in the later Permian, or in the Trias. They constitute at best but a transition form, and are not sufficiently abundant to be likely to be discovered in a fossil state. It is a remarkable fact that the earliest remains of both the *Monocotylæ* and the *Dicotylæ* have been found

DIAGRAM SHOWING THE SUPPOSED LINES OF GENEALOGICAL DESCENT OF VASCULAR PLANTS.

in the same formation, viz: the Chalk, and although their first actual appearance may date back into the Jura or Trias, it is probable that in point of time the two great classes of Angiosperms had a nearly simultaneous origin. Whether either of these great vegetable types has reached its highest destiny on the earth it is impossible with certainty to affirm, but the indications are that, for the *Dicotylæ* at least, progress in organization is still going on.

In order to complete the systematic survey of the vegetable kingdom from the point of view of genealogical descent, the following logical scheme of classification is appended for comparison with the genealogical scheme presented on a preceding page:



THE MODE OF EXTRICATION OF SILKWORM MOTHS FROM THEIR COCOONS.

BY A. S. PACKARD, JR.

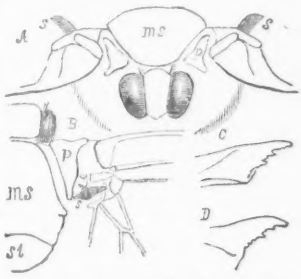
WITHOUT having made extended research in the literature of entomology, the only account which we have been able to find of the mode of extrication of the silkworm moths from their cocoons is that given by Kirby and Spence in their chapter on the pupa state of insects, vol. iii, pp. 280–283, which is quoted below, as it gives a summary of what was known up to the year 1828, while so far as we are aware nothing has since then been recorded on this interesting subject, except the observations of Mr. L. Trouvelot (AMERICAN NATURALIST, vol. i, pp. 33, 34); the brief statement in Lacordaire's Introduction a l'Entomology (1834, p. 201) being evidently based on Réaumur's observations.

The texture of the cocoon of the silkworm moth is uniform in every part, and the layers of silk are equally thick at both ends. The moth makes its way out by cutting or breaking these threads at the end opposite to its head; an operation which, as it destroys the continuity of the silk, those who breed these insects are particularly careful to guard against, by exposing the cocoon to heat sufficient to destroy the included pupa. The question is, what instruments does the moth employ to effect this? And this we are not able to answer satisfactorily. Malpighi asserts that the animal first wets the silk with a liquid calculated to dissolve the gum that connects the threads, and then employs its lengthened head to push them aside and make an opening. But, as Réaumur has observed, besides that so obtuse a part as the head of a moth is but ill-fitted to act as a wedge, we find the threads not merely pushed to each side, but actually cut asunder. He therefore infers that the eyes, which are the only hard organs of the head, are the instruments by which the threads are divided—their numerous minute facets serving the purpose of a fine file It should be observed, however, that Mr. Swayne confirms Malpighi's assertion that the silk worm does not cut but merely pushes aside the threads of its cocoon, and he informs us that he has proved the fact by unwinding a pierced cocoon, the thread of which was entire. Yet Réaumur's correctness cannot be suspected, and he affirms that from observation there can scarcely be a doubt that most of the threads are broken; which is further confirmed in an account of the breeding of silkworms published in the American Philosophical Transactions, in which it is expressly stated that cocoons out of which the fly has escaped cannot be wound. Analogy, it must be confessed, is against Réaumur's opinion, since other kinds of silkworms make their

escape by means of a *fluid*. Thus we are informed by Dr. Roxburgh that *Attacus paphia* when prepared to assume the imago, discharges from its mouth a large quantity of liquid, with which the upper end of the case is so perfectly softened as to enable the moth to work its way out in a very short space of time, an operation which, he says, is always performed in the night. Perhaps the two opinions may be reconciled by supposing the silkworm first to moisten and then break the threads of its cocoon. In those that are of a slighter texture, a mere push against the moistened end is probably sufficient, and hence we find in so many newly-disclosed moths the hair in that part wet and closely pressed down. If it be apparently difficult for the silkworm moth to effect an opening in its cocoon, how much harder must seem the task of the puss moth (*Cerura vinula*) to pierce the solid walls of its wood-thickened case? Here the eyes are clearly incompetent; nor could any ordinary fluid assist their operation, for the gum which unites the ligneous particles is indissoluble in aqueous menstrua. You begin to tremble for the fate of the moth incarcerated in such an impervious dungeon, but without cause; what an *aqueous* solvent cannot effect, an *acid* is competent to, and with a bag of such acid our moth is furnished. The contents of this she pours out as soon as she has forced her head through the skin of the chrysalis, and upon the opposite end of the cocoon. The acid instantly acts upon the gum, loosens the cohesion of the grains of wood, and a very gentle effort suffices to push down what was a minute ago so strong a barrier.

Our attention was called to this subject by a rustling, cutting and tearing noise issuing from a cocoon of *Actias luna*, the large green swallow-tailed silkworm moth. On examination a sharp black point was seen moving to and fro, and then another, until both points had cut a rough irregular slit, through which the shoulders of the moth could be seen vigorously moving from side to side. The hole or slit was made in one or two minutes, and the moth worked its way at once out of the slit. The wings at this time being very small and flabby, and the shoulders being alternately much raised, the points stuck up far enough to cut or saw through the cocoon. The wings were at first of a deep buff yellow, but in half an hour after, the wings began to expand more than before and to turn green. The black points, when the wings are fully expanded, can be detected, not being entirely covered by the hairs at the base of the wing. In this case no fluid was seen to exude from the mouth, and the cocoon was perfectly dry.

On examining two dry denuded specimens of *A. luna*, the black spine was seen at the base of each fore wing, and external to but opposite the end of each patagium. The spine, which may be called the *sector coconis*, is figured by Mr. J. S. Kingsley in the accompanying cut. A represents the specimen of *A. luna* which came out of the cocoon and died with the wings not expanded. It represents a front view of the moth with the shoulders elevated and the rudimentary wings hanging down; *s*, the cocoon-cutter; *p*, patagium. B represents another specimen with fully developed wings; *ms*, scutum; *st*, scutellum of the mesothoracic segment; *s*, the cocoon-cutter, which is evidently a modification of one of the pieces at the base of the fore wings; it is surrounded by membrane, allowing free movement. C and D are different views of the spine considerably magnified, showing the five or six irregular teeth on the cutting edge, the spine being sharp, curved and conical. It will be seen that it acts like a rude saw.



Cocoon cutter of the *Luna* moth.

A number of other members of the sub-family *Attaci* were examined, and this cocoon-cutter was found to be present in all. In *Telea polyphemus* it is large and well developed, though according to Mr. Trouvelot the moth does not apparently need it; still, fresh observations directed to this point may show that it is put to active use. In *Callosamia promethea*, *Platysamia cecropia*, and *P. gloveri* it is rather small. Its use in this latter genus, where the cocoon is left partly open at one end does not seem necessary, still it may come in play while the moth is pushing through the threads which it first encounters. In *Samia cynthia*, and an *Attacus* from Nicaragua, and *Attacus amazonia* Pack. from Pebas, Peru, the cocoon-cutters are rather small, about one-half as large in proportion as in *A. luna*, yet the spines are black. It is large and well marked in the European *Saturnia pavonia-minor* and *Endromis versicolora* Linn.

In *Bombyx mori* the spines are not well marked, and they are quite different from those in the *Attaci*. There are three sharp points, being acute angles of the pieces at the base of the wing. Their relations need examining in alcoholic specimens which we

have not at hand. Still it must be these saws which perform the cutting described by Réaumur. No such spines are present in *Eacles imperialis.*

These observations have been thrown together with the hope of stimulating fresh observations among those raising silkworm moths. Particular attention should be paid to *Telea polyphemus*, in which the cocoon cutter is so well developed, and where its use would seem to be dispensed with, according to the observations of Mr. Trouvelot.

Since the foregoing lines were put in type, I have observed several *Platysamia gloverii* and one *P. columbia* either in the act of making its way out of its cocoon or immediately after. In no case was any cutting or tearing noise heard, though the cocoons were all within a foot and a half of my head, on my study table. I do not believe that the cocoon-cutters, though well developed, are used at all. (In fact, just as I had written the preceding sentence, a male came out of its cocoon, and my attention was first called to it by the rustling it made in creeping over the loose cocoons in the box; no noise was heard previous to its appearance on the outside of the cocoon.)

The inside of the cocoons of *Platysamia cecropia*, *columbia*, and *gloverii*, is glazed to within about a quarter of an inch of the anterior end of the cocoon, beyond it is rough and the silk fibres are capable of being distended and softened by the copious fluid poured out by the moth. The pupa splits along the whole back, sometimes to the end of the abdomen. Before issuing from the cocoon the wings expand much more in *P. gloverii* and *columbia* than in *A. luna;* at least just as the moths work their way out of the cocoon, and before they are entirely extricated, the wings are nearly an inch long. They evidently pull themselves through the aperture by their legs. Previous to extrication they discharge from the mouth a fluid which moistens the silk threads, and also the hairs of the head and thorax, together with the antennæ. This is invariably the case. The insect must with difficulty draw itself through the aperture, which scarcely admits the little finger.

The wings expand fully in from fifteen to forty minutes, usually about thirty minutes, but the moths are not capable of flying for an hour or so after. The moth hangs suspended to some object, with the wings and antennæ drooping down. Though I hatched out several males and females at a time, at different periods, none united sexually, though the females laid eggs.

The cocoon of *P. gloverii* differs from that of *P. cecropia* in being perhaps tougher and paler, more glistening in hue, though of the same form and size. It it always quite distinguishable from that of *P. cecropia*. The cocoon of *P. columbia* only differs from that of *P. gloverii* in its smaller size, and the more distinct patches of silk material scattered on the outside; it is of the same form as in the two other species.

I am indebted to Mr. J. L. Barfoot for a number of cocoons of *P. gloverii*, from near Salt Lake City, Utah, and to Prof. C. H. Fernald and Mr. Anson Allen, of Orono, Maine, for the cocoons and imagoes of *P. columbia*.

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RECENT LITERATURE.

HUXLEY'S MANUAL OF THE ANATOMY OF INVERTEBRATED ANIMALS.[1]—The great advances, within the past ten years, in our knowledge of the anatomy of animals, renders the appearance of this book timely. No one is better fitted than Prof. Huxley to prepare such a manual, which should be authoritative, compact, clearly written, and catholic in its treatment. This book, together with Siebold's Anatomy of the Invertebrates, will form a condensed library for the teacher and student. Prof. Huxley has made a good innovation on the plan of similar books in introducing detailed and more or less illustrated accounts of the anatomy of common types of animals, so that with the aid of this manual the ordinary student can, in a measure, become his own teacher. As a body of well digested facts, clearly and elegantly stated, this book is without a rival.

The classification we should find some fault with, as we do with some of Prof. Huxley's work in this direction, owing, we think, to an inherent lack of perspective in the learned author's mind. For example, the Cœlenterates are described near the beginning of the book, and the Echinoderms near the end; the worms, crustacea, insects, the Polyzoa, Brachiopods and molluscs are then described, and finally we are led to the Echinoderms; the Ascidians coming last, the work closing with the *Peripatidea*, *Myzostomata*, *Enteropneusta*, *Chætognatha*, *Nematoidea*, *Physemaria*, *Acanthocephala* and *Dicyemida*. This arrangement may be in part accounted for by the fact that the book was apparently two years in going through the press, and two years has made a great difference in our knowledge of these last-named groups; but there is no good reason, it seems to us, for separating certain groups so far from those to which they are evidently allied, even

[1] *A Manual of the Anatomy of Invertebrated Animals.* By THOMAS H. HUXLEY. New York. D. Appleton & Co. 12mo. With figures. $2.50.

in a book like this, in which systematic zoölogy is left out of account. The defect is due, we think, to the analytic rather than synthetic turn of mind of its author, and not to the want of adequate knowledge now in the hands of the naturalist.

Few errors of statement will probably be found in this book. We may be allowed to refer to some points to which we should take exception: "Foraminifera," says our author, "are *Monera* of the *Protogenes* type." It is now proved that *Foraminifera* have a nucleus, as stated near the close of this manual, and should be, as they always have been, retained among the *Radiolaria;* why Prof. Huxley should place them among the Monera, which have no nucleus, is a matter of surprise. He regards Eozoön as an incrusting form of Foraminifer, not stating the serious objections that have been made as to its animal nature, and then adopts, as possible, Wyville Thompson's suggestion, that "the enormously thick azoic slaty and other rocks, which constitute the Laurentian and Cambrian formations, may be to a great extent the metamorphosed products of foraminiferal life"!! This really takes our breath away. We leave the matter in the hands of the geologists. Then it is added oracularly, "And there may be no part of the common rocks, which enter into the earth's crust, which has not passed through a living organism at one time or another." Are we not here dealing with a physiology and anatomy not of our earth?

Spongilla is stated to be, among sponges, "the sole fresh-water form." Prof. H. James Clark's *Siphydora echinodes* is said by him to be common in ponds and streams in the United States (Mind in Nature). It is stated that the embryos of *Radiolaria* are "provided with a single flagellam;" in *Collosphæra*, however, there are two. The young Limulus is said, as "Dohrn points out" (1871), to bear a remarkable resemblance to the trilobite *Trinucleus;* this was, however, pointed out by Packard, at some length, with figures both of young *Limulus* and *Trinucleus* nearly a year previous, in this journal for October, 1870. Again, Huxley states, speaking of the metamorphosis of *Atax bonzi*, "The proper vitelline membrane bursts into two halves, much as in *Limulus*, and the deutovum emerges." In *Limulus*, assuredly, the membrane which is referred to as splitting open is the chorion.

The classification of the Arthropoda is essentially artificial, and in it we doubt if the author evinces his usual acumen, certainly a feeble grasp of the subject. The trilobites are associated with the tardigrades and Pentastomida into a division "I. without Gnathites." The trilobites by general analogy are obviously to be associated with the *Merostomata* and Limulus, and, since the publication of this work, Mr. C. D. Walcott has discovered that they possessed "four pairs of manducatory jaws;" and why should *Trilobita* be associated thus with *Tardigrada* and *Pentastomida* when both the latter groups are undoubtedly low Arachnids?

Again, the Arachnida are placed in a division with "pediform Gnathites," but in what respect are the mandibles and maxillæ of spiders and mites any more pediform than those of insects and Myriopods? And in the sucking Myriopods we have an entire family with mouth parts not much higher in grade than those of the Tardigrades and Pentastomida.

The author shows a tendency to coin terms for parts already named, thus *gonapophysis* is used instead of Lacaze, Duthier's elegant term *rhabdite* for the blades of the ovipositor. The term *Echinopædium* is used for the larva of Echinoderms, which exactly corresponds to Packard's *Cephalula*, proposed in this journal (May, 1875, p. 283, and Life Histories, p. 94) and extended to embrace a similar phase in molluscs and worms, as well as Echinoderms. But these are the merest blemishes in a work quite indispensible to students, and the production of one whose general accuracy of statement is universally recognized.

Hunt's Chemical and Geological Essays.[1] — No changes appear to have been made in the text beyond the correction of typographical errors, but in the preface to the second edition, Prof. Hunt takes the opportunity to farther notice the question of the temperature of the earth's surface in former geological periods. He concludes that a reduction in the weight of the atmosphere in early geological times, by causes to which he alludes, must have produced a considerable refrigeration of climate, and a still greater cooling of the globe by the diminution of the proportion of carbonic dioxyd contained in the atmosphere. He concludes as follows: "Geographic changes, though a true cause of local variations of climate, and adequate to explain the greater refrigeration of certain areas since the commencement of the pliocene, are not sufficient to account for the warmer climates of previous ages, and we conclude that the cause of these is to be found in the former greater volume and different chemical constitution of the atmosphere, as already set forth.

"This view is opposed to the hypothesis maintained by many geologists of an alternation of warm and glacial climates at the surface of the earth, repeated from the earlier times. Dawson and Heer, however, from the study of the fossil floras found in arctic regions, from the devonian to the miocene, conclude that palæontology affords no evidence of such a condition of things, and the observations of McCoy, Hector and Hutton in the southern hemisphere lead them to similar conclusions. The nurseries of these successive northern floras appears to have been in the arctic regions, and their spread southward would, according to Dawson, be due to continental elevations, bringing about, at irregular periods, a cooler climate in the northern temperate zone.

[1] *Chemical and Geological Essays.* By Thomas Sterry Hunt, LL.D., etc. Second edition. Revised, with additions. Salem, S. E. Cassino, Naturalist's Agency. 1878. 12mo, pp. 489.

It may even be conceived, as well remarked by J. F. Campbell, that such elevations might bring large areas of the earth's surface into the region of perpetual frost, thus giving rise to local glacial phenomena, while a warmer climate prevailed everywhere at the sea level. Nordenskiöld declares that he sought in vain for evidences of ice action in the various sedimentary deposits in Spitzbergen.

"In regard to a suggested explanation of former climatic conditions, the author may be permitted to quote the following language used by him in 1876: 'Recent speculations have revived the old notion of a possible change of the earth's axis of rotation as a way of explaining this change of arctic climate; but such a phenomenon is astronomically improbable, and is also opposed by the fact that the direction of the oceanic currents, which are guided by the earth's rotation, appears, from the distribution of marine sediments to have been the same since very early periods.' Dawson has since urged the same argument, and reinforced it by recalling the fact that the southward migrations of successive floras, not less than the lines of distribution of mechanical sediments in past ages, show that from early palæozoic time the general courses of the oceanic currents, and consequently the position of the earth's axis have not changed."

It seems to us that this is the soundest and best exposition of the question of pre-quarternary glacial climates that we have met with.

The Taconic rocks are further discussed, and the name Taconian suggested for the lower Taconic series. These Taconian rocks are regarded by the author as corresponding to "four great series of pre-Cambrian rocks, and mark as many successive periods in eozoic time." With a reference to recent views on the origin of crystalline rocks, and a re-affirmation of the neptunean views of the author, the preface closes.

Botanical Directory.—The Botanical Directory for America for 1878, will be found exceedingly convenient. Part I gives the names of botanists and their state, while their full addresses will be found in Part II, where the names are arranged by states. The price of this useful directory is forty cents, three copies for one dollar. The list is a large one, and it is only to be desired that a larger portion of those whose names appear were so situated as to be able to be actively engaged as investigators.

Watson's Index to North American Botany.[1]—This is a compact volume compiled and printed with great evident care, and is a laborious and useful work. It is intended to facilitate

[1] *Bibliographical Index to North American Botany; or Citations of Authorities for all the recorded indigenous and naturalized species of the Flora of North America, with a Chronological Arrangement of the Synonomy.* By Sereno Watson. Part I. Polypetalæ. Smithsonian Miscellaneous Collections. 258. Washington, March, 1878. 8vo, pp. 476.

the labors of botanists by furnishing references to all the published descriptions of species of North American plants, with a chronological arrangement of the synonomy. This part covers the ground of Vol. I of Torrey and Gray's Flora of North America. The territory embraced includes Greenland and the Arctic coast on the north, and the borders of Mexico closely adjacent to the United States on the south. The citation of authorities of the species west of the Mississippi and northward is designed to be full and complete, and the same may be said for the Atlantic States before 1840. The work has demanded a good deal of herbarium labor, and will give an undoubted stimulus to botanical studies.

RECENT BOOKS AND PAMPHLETS.—Some microscopical observations of the Phonograph Record. By Persifor Frazer. (Read before the Am. Philos. Society, April 5th, 1877). 8vo, pp. 16.

The Louisville Limestones, &c. By Jas. Hall. (Palæontology of New York, Vol. V, part 2. Advance sheets, Nov. 1877.) 4to, pp. 16.

Studier öfver mjölkdentitionen och tändernas Homologier hos Chiroptera. Af Wilhelm Leche. 4to, pp. 47. Pl. 2. Lund. 1875.

Studien über das Milchgebiss und die Zähnhomologien bei den Chiropteren, von Wilhelm Leche. An abstract of the proceeding in Archiv f. Naturgesch. xxxxiii. Bd. I. 1877.

Report of Prof. Joseph Henry, Secretary of the Smithsonian Institution, for the year 1877. Washington Gov. Printing Office, 1878. 8vo, pp. 50.

The Geographical distribution of the Mammalia, considered in relation to the principal Ontological regions of the Earth, and the laws that govern the distribution of animal life. By Joel Asaph Allen. Bulletin of the U. S. Geolog. and Geograph. Surv. IV, No. 2. 8vo, pp. 175. Washington, 1878.

On the Janssen Solar Photograph and Optical Studies. By S. P. Langley. 8vo, pp. 5. New Haven, 1878.

A commonly accepted theory in ophthalmic physiology disproved by a crucial experiment. By Henry Hartshorne, M.D. 8vo, pp. 2. (Extracted from the Am. Journ. Med. Sciences, for April, 1878.

Water Supply of the State of New Jersey. Report of a Committee, A. R. Leeds, Chairman. 8vo, pp. 17. Philadelphia, 1878.

On the Asphaltic Coal from the shale of the Huron River, Ohio, containing seams of Sulphate of Baryta. By A. R. Leeds, with a geological note by J. S. Newberry. Read Jan. 11, 1875. 8vo. pp. 2.

Notes on the Locust in the North-west, in 1876. By George Dawson, F. G. S., &c. (From the Canadian Naturalist, Vol. VIII, No. 7.) 8vo, pp. 7. 1878.

On the Mechanical Genesis of Tooth-forms. By Jno. A. Ryder. (Proc. Phil. Acad. Nat. Sci. 1878.) 8vo. pp. 36.

Material for a Bibliography of North American Mammals. By Theodore Gill and Elliott Coues. Appendix B, extracted from the eleventh volume of the final reports of the Government Survey. 4to, pp. 131. Government Printing Office, Washington, 1877.

Original memoirs and clinical lectures. By H. C. Wood, Jr. 8vo, pp. 4. Philadelphia, 1878.

Polarity in character: A study of the sex of mind. By Richard Randolph. 8vo, pp. 20. Philadelphia, 1878.

Recherches sur les fossiles paléozoiques de la Nouvelle-Galles du Sud (Australie); par L.-G. De Koninck, Docteur en Sciences, etc., etc. Text 8vo, pp. 225, accompanied by 4to plates, V–XXIV. Bruxelles, 1876–77.

Palæontological Bulletin, No. 29, Descriptions of Extinct Batrachia and Reptilia from the Permian Formation of Texas. By E. D. Cope. (Published May 8, 1878.)

Ueber Laichen und Entwikelung des Ostsee-Härings. Von Dr. C. Kupffer (aus dem Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel). Berlin, 1878. 4° pp.

U. S. Geological Exploration of the Fortieth Parallel, Clarence King, Geologist-in-charge. Vol. 2, Descriptive Geology, by Arnold Hague and S. F. Emmons. Illustrated by 26 plates. Washington, 1877. 4° pp. 890. Vol. 4, Part 1. Palæontology, by F. B. Meek. Part 2, Palæontology, by James Hall and R. P. Whitfield. Part 3, Ornithology, by Robert Ridgway. 24 plates. Washington, 1877. 4° pp. 669.

The Louisville Limestones. Note on the Hydraulic Beds and associated Limestones at the Falls of the Ohio. Palæontology of New York, V. Part 2. Advance sheets. Nov. 1877. 4° pp. 16.

Supplement to the second edition of Acadian Geology, containing additional facts as to the geological structure, fossil remains and mineral resources of Nova Scotia, New Brunswick and Prince Edward Island, by J. W. Dawson, F. R. S., etc. London. MacMillan & Co., 1878. 8° pp. 102.

Sur la Découverte d'un orthoptère coureur de la Famille des Phasmiens dans les Terrains supra-houillers de Commentry. *Protophasma dumasii.* Par M. Charles Brogniart. 8° pp. 4.

The Distribution of the Till in New Hampshire, Massachusetts and Long Island. By Warren Upham. From the third volume of the Final Report upon the Geology of New Hampshire. Concord, N. H. 1877. 8° pp. 24.

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GENERAL NOTES.

BOTANY.

CLEISTOGAMOUS FLOWERS OF DANTHONIA.—I have been much interested in the article in the April number of the NATURALIST, by C. G. Pringle, on the Cleistogamous Flowers of *Danthonia*. *D. spicata* is very common in all our dry, sterile, or rocky woods; occasionally some bunches occur in moist ground, and these can readily be pulled out by the roots, with no disposition to separate at the lower joints; but when the plant grows in dry ground, as it usually does, the culms separate near the root without much difficulty. This I have always considered was due not so much to the plant itself, as to the place of growth; the firm hold the fibrous roots have to the ground, would cause a separation when the plant is pulled vigorously, many others act the same way. With *Danthonia sericea*, however, my experience has been very different from that of Mr. Pringle. This species is quite frequently met with in the dry loose sand in the Pine-barren region of New Jersey, growing in little tufts; in that respect somewhat different in habit from *D. spicata*. Last June whilst botanizing near Egg Harbor City, in this State, I found a large number of these tufts, each having from 6 to 20 culms, and so brittle or readily disarticulating at the lower joints, that it was with great difficulty that I could secure a decent specimen; on endeavoring to pull up the plant, in every instance the separation occurred; the only way to succeed was to dig out the roots without touching the stem at all, and even then the effort to shake off the loose sand, often caused the culm to break away. Our specimens of *D. spicata* very frequently have a few flowers in the axils, but I have never seen any in *D. sericea*.—*Isaac C. Martindale, Camden, N. J.*

MEANS BY WHICH PLANTS ARE PROTECTED FROM ANIMALS AND UNFAVORABLE WEATHER, ETC.—Under this title Otto Kuntze has published a work which has been reviewed in Trimen's *Journal of*

Botany. From animals plants are protected by possession of runners; by close growth (thus effectually banishing animals too large to force a passage); by growing under sheltering bushes (this applies of course to herbs); by twining habits; by epiphytic habits; by presence of spines and thorns (protection against grazing birds); by all forms of trichomes (these, besides hindering browsers, prevent crawling up of insects, &c.); by production of organs and tissues suitable to ant-habitation; by growing in water, and by having leaves adapted to hold water at their bases; by rings of hairs on stems, &c. (against crawling insects); by slippery, waxy surfaces; by milky sap (this, besides being poisonous to grazing animals, by its exudation impedes the movements of small climbing creatures); by presence of ethereal oil in all parts, including the seed (drives away insects); by corky tissues; by possession of leathery leaves which may be distasteful to grazing animals; by development of tubers, bulbs and allied structures; by revolution of leaf margins and of corolla-tips (renders climbing difficult to ants); by the absence of chlorophyll; by poisonous or bitter principles developed chiefly in seeds, these also being protected by their hardness, leathery consistence and small size.

Protections against unfavorable weather are — runners (which support plants against over-weight of snow in alpine and polar regions, and by admitting of a complete covering of snow are enabled to resist the otherwise fatal effects of frost); aëriel roots —props against land-storms and dash of the waves; gregarious habits lessening the force of the winds, a result accomplished also by the horizontal position of the branches, by development of small scaly leaves, and by possession of leafy crowns, deep roots and strong or slim stems; hairy clothing, which protects against cold, rain and undue transpiration, and also intercepts and retains rain and dew; irritability to light or touch; possession of a waxy outer layer and of a strong cuticle; a thick sap which, owing to the hygroscopic property of its solid constituents, keeps the circulation active during the period of greatest sun-heat and dry season; ethereal oils which gradually evaporating, produce resin, a layer of which accumulating on the evaporating surfaces, lessens the amount of transpiration; the thick sap of plants growing in deserts, when the difference between the temperatures of day and night is very great, protects them against injury from the daily great variations of temperature; phyllodes, and leaves occupying the position of phyllodes, being less transpirable, are adaptations to a dry climate; presence of corky tissues which protects against frost, etc., absence of stomata, which in some cases prevents entry of thawing snow; thickened roots, &c., which are stores of nutriment and water, and preserve life during times of drought; besides the many arrangements by which the reproductive organs are protected from rain, dew and wind.

My Hepaticas.—One of the interesting things for the botanist or the gardener to do at this time of year, is to remove to some spot in his garden a few of the most attractive wild plants which abound in our woods, swamps and fields. Last year, I removed some plants of blood-root, tooth-wort, spring beauty, phlox, squirrel corn, several species of violets and several *varieties* of hepaticas. These are near the house and are a constant source of delight to the children, visitors, members of the household, and I hardly need add to the person who transplanted the flowers. These were removed as they were found with a little earth about the roots.

Two or three plants of the hepatica were chosen for the pure white of their flowers, others for their delicate pink color, others for the large size of their flowers, others for the deep blue of the flowers; still others were selected for their double flowers. This spring the hepaticas are all true in their peculiarities. One of the blue varieties has already begun to sport. One stem bore two flowers near the top and another three. On a much larger scale I am collecting plants for a wild garden on the bank of a brook and a small pond near the green-house. Here we have a variety of soil from pond to muck or dry sand; from perpetual shade to a full exposure of the bright sun. Here are ferns and grasses, some shrubs and some of the most interesting hardy wild plants. It is a favorite spot for all who live at the College.—*W. J. Beal, Michigan Agricultural College.*

Botanical Notes.—The Botanical Gazette for April, contains, among other articles, bryological notes by C. H. Austin; new species of Colorado fungi, by C. H. Peck; late Rhode Island flowers, by W. W. Bailey; Coniferæ of the Crestines, by T. S. Brandegee. The bulletin of the Torrey Botanical Club for March contains descriptions of new species of North American *Uredinei*, and an interesting table showing the dates when the leaves fall, by N. L. Britton, who states that "the female in dicœcious plants appears to hold its foliage longer than the male." Caruel's New Botanical Journal (Italy x, No. 2), contains an article on the floral structure and affinities of various monocotyledonous families.

In the *Quarterly Journal of Microscopical Science* are two important papers, one by S. H. Vines, on Researches into the Nature of Lichens, and a very important paper, well illustrated, by J. C. Ewart, on the life history of *Bacillus anthracis*.

ZOÖLOGY.[1]

Helix chilhoweënsis Lewis.—I have lately had the pleasure, after a pedestrian excursion of nearly one hundred miles, over the roughest of mountain roads, to collect this rare species in its normal habitat.

[1] The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

This shell is held by Mr. Binney, if I mistake not, to rank only as a variety of the *H. diodonta* Say. In this Mr. Binney is following, no doubt, closely in the line of recent zoölogical testimony; but if this species is to be held as a synonym, it will be difficult to convince any fair-minded student of our shells, that, under the same law of interpretation, *H. major* Binney, is not a synonym of *H. albolabris* Say, as held by Mr. Bland; or that *Zonites subplanus* Binney, is other than a variety of *Z. inornatus* Say; or *Z. capnodes* Binney, anything but a variety of *Z. fuliginosus* Griffith. A "general resemblance" in the "jaws" and "linguals" of certain groups, so vague as to render the expression "jaw as usual in the group" sufficiently definite, makes a very convenient post about which to lash the whip of synonyms; but there are other characters, which only the collector can know, that ought, it seems to us, to be taken notice of in all our accounts with authors who have written upon species.

The writer first found the large variety of *H. diodonta* several years ago in Whitley County, Kentucky. He has since collected it in numerous localities of the Carboniferous sandstone region of South-eastern Kentucky and Northern Tennessee, and it has never failed, in a single specimen, to exhibit its normal characters, save in the single particular of size. While shells have been found nearly double the dimensions of Maine specimens received from Mr. Allen, and nearly treble those of New York examples from Dr. Lewis, none have ever been seen, at all approaching, in this particular, the smallest specimens of *H. chilhoweënsis.* The latter shell has nearly one whorl more than the *H. diodonta;* it has no tooth on the lower third of the peristome, and at least one-half the specimens which I have collected want the parietal tooth. My largest specimen measures 39 mill. in diameter and 20 mill. in height. There is very little variation in the size of the specimens which I have seen. The animal is slender, quite sluggish in movement, and not timid as is the case with *H. diodonta.* The surface is roughened with irregular, reniform tubercles, the tentacles are very long and delicate, and the foot attenuate and keeled posteriorly.

It has a habit of greatly flattening and spreading its foot, especially after full-feeding, and will in that condition, remain for hours upon smooth surfaces of planed boards, pebbles or lettuce-leaves, evidently in calm enjoyment of its meal, having, in this respect, the exact habit of the European *H. pomatia* L. It inhabits the dense thickets and Kalmia jungles of the Jellicoes, and is rare, even in its native habitat.

The great size of this shell, and that of other species of wider range found with it, offers an argument controverting the prevailing opinion that limestone regions only are favorable to molluscan life.

These shells are found in the carboniferous sandstone mountains

of Tennessee; and among their northern radices or foot-hills in Kentucky, I several years since collected the largest specimens, which I have ever seen, of several common Ohio species. It is fair to remark, however, that the shells are fewer in numbers, both of species and specimens, though so enormously developed in size. Exceptions exist, nevertheless, in both cases. During the present excursion I took specimens of *H. tridentata* Say, measuring 25 mill. in diameter, and specimens of *Z. inornatus* Say, (*subplanus?*) measuring 23 mill. Associated with these, however, was a variety of the *H. hirsuta* Say, with which all southern collectors are familiar, much dwarfed in size, rounded, and approaching in form the *H. maxillata* Gould. The *H. stenotrema* Fer. from the same locality is very large, and very abundant, as is also the small variety of *H. hirsuta*. Very large specimens of *Z. sculptilis* Bland, were found, measuring 11 mill. in diameter.

Associated with these shells was, also, the very rare *H. wetherbyi* Bland. But one living example of this shell was taken when the species was discovered. To this one Mr. George S. Huntington afterwards added two or three living specimens which he collected in the foot-hills of the Jellicoes. To these the present excursion has added a very few. This species is distributed, so far as traced, through the carboniferous sand hills of southern Kentucky and northern Tennessee, but occurs only rarely, at the foot of cliffs under leaves, or deeply buried under well-rotted logs. The shell is often coated with a mass of sticky dirt, made up of earth and the mucus secreted by the animal, which it is impossible to remove, unless after thorough soaking, without stripping the epidermis from the shell. The animal is blueish-black and finely granulated; the tentacles are very slender and the foot attenuated and sharply keeled behind. This interesting species will probably remain rare in collections, if we may judge fairly, after various endeavors to find it in greater numbers; and the more especially, because a vicious custom prevails in that country of firing the woods every Spring, to consume the leaves fallen from the trees, and encourage a scanty growth of grass upon which the half-starved stock of the idle inhabitants subsists. Only in sheltered nooks that the fire-fiend never reaches, and in the region of springs and mountain brooks are the molluscs safe. But even under these discouraging circumstances, the Jellico range offers a wide field for future discovery. We found here, growing luxuriantly with the *Kalmia*, the beautiful *Lygodium palmatum* Schwartz, the *Epigæa repens* L., the *Gaultheria procumbens* L. and other plants common in more northern mountain regions. Species of rare *Coleoptera* are not uncommon, and no doubt many new species, in all departments of zoölogy, await the explorer who may have the courage and endurance to summer in the foot-hills of the Jellicoes.—*A. G. Wetherby.*

NOTICE OF THE SPIDERS OF THE "POLARIS" EXPEDITION.—The spiders collected by Dr. Bessels during the Arctic Expedition of the "Polaris," are, as might have been expected, very few in number, only *four* species (in *eight* examples) having been brought home. Of these four species two belong to the genus *Erigone*, one to *Lycosa*, and one to *Trochosa;* only one, a small *Erigone*, appears to be new to science, the other *Erigone*, as also the *Lycosa* belong to species that seem to be rather widely spread in the Arctic regions. The *Trochosa* must for the present be left undetermined, the example being undeveloped, and in a very bad state of preservation. All the examples are from West Greenland, and, with exception of the *Lycosa*, which bears the locality: "Foulke Fiord" (at about 78° 20′ lat.), they were all collected at Polaris Bay (about 81° 30′ lat.). The two species of *Erigone*, and probably also the *Trochosa*, are new for Greenland.

In a former paper[1] I have stated that the number of the species of spiders up to that time observed in Greenland, were probably eighteen, described or mentioned partly by O. Fabricius in his Fauna Grœnlandica, and partly by myself. L. Koch[2] has since published a new Greelandian *Lycosa*, *L. aquilonaris;* and Cambridge[3] has lately, besides several other species from the Arctic parts of America, etc., described three new species: *Dictyna borealis*, *Erigone wkymperi* and *Linyphia turbatrix* from Greenland,[4] in which part of America, accordingly, twenty-five different species of spiders have hitherto been found. For five of these species, however, only the genera to which they belong have been indicated, for one (*Ar. notata* O. Fabr.) both the genus and the species are uncertain. The number of tolerably well known Greenland spiders is, therefore, as yet only nineteen.[5]

The species of the Polaris Expedition are as follows:

1. *Erigone pschychrophila* Thor.

Syn. 1872. *Erigone psychrophila* Thor., om Arachnider från

[1] Om några Arachnider från Grönland, in Öfvers. af Vet.-Akad. Förhandl., XXIX (1872).

[2] Die zweite deutsche Nordpolarfahrt in den Yahren 1869 und 1870, etc., II Band, Wissenschaftliche Ergebnisse, I Abtheil, p. 400–403.

[3] On some new and little known spiders from the Arctic Regions, in Ann. and Mag. of Nat. Hist. 4 Ser., XX (1877).

[4] *Thanatus formicinus?* Cambr. and *Th. arcticus* Thor. are probably the same species.

[5] These nineteen species are: *Epeira diadematа* (Clerck), *Tetragnatha Grœnlandica* Thor., *Linyphia turbatrix* Cambr., *Erigone psychrophila* Thor., *E. wkymperi* Cambr., *E. penessa* Thor., *E. frigida* id., *E. vaginata* id., *E. spetsbergensis* id., *E. modesta* id., *Steatoda bipunctata* (Linn.), *Dictyna hamifera* Thor., *D. borealis* Cambr., *Thanatus arcticus* Thor., *Lycosa Grœnlandica* id., *L. glacialis* id., *L. aquilonaris* L. Koch, *Trochosa insignita* Thor., and *Epiblemum scenicum* (Clerck). Of these species *Epeira diadematа*, *Steatoda bipunctata* and *Epiblemum scenicum* are taken upon the authority of *O. Fabricius.* "*Ar. rufipes* Linn." of that author is probably a collective name for several of the above named and other *Erigones;* the true *E. rufipes* (Linn.), Sund. has not, as far as I know, been found in Greenland.

Spetsbergens o. Beeren Eiland, in Öfvers. af Vet.-Akad. Handl., XXVIII (1871), p. 689.

Syn. 1877. *Erigone psychrophila* Cambr., on some new and little known Spid. fr. the Arctic Regions, loc. cit., p. 278, Pl. VIII, Fig. 4.

Of this remarkable spider three full grown males and two females were captured at Polaris Bay, June 3, 1872.

2. *Erigone penessa*, n.—Black, with palpi and legs blackish-yellow, mandibles yellowish, longitudinally striped with black; pars-cephalica elevated, strongly convex transversely, lateral eyes not contiguous, anterior laterals largest of the eight, oval and oblique, area occupied by the middle eyes (of which the anterior are slightly smaller than the posterior, and separated by a very small interval), rather longer than broad, much broader behind than in front; vulva consisting of a shallow transversal fovea, limited behind by a brown shining costa narrowing from the extremities towards the middle, and slightly curved forwards. ♀ *ad.* Length nearly 3 millim.

Female.—Cephalothorax inversely ovate, shining, rather shorter than tibia and patella of the fourth pair, moderately rounded in the sides of the pars thoracica, rather strongly narrowed and slightly sinuated at the pars cephalica; the forehead is rounded, and its breadth equals about two-thirds of the breadth of the pars thoracica; the cephalic furrows are strongly marked; the pars cephalica is elevated and transversely very convex, and provided with several short hairs between the eyes, and a longitudinal row of three longer hairs behind. Seen in profile the back of the cephalothorax rises gradually from the hind margin to the hinder part of the pars cephalica, the back then becoming somewhat sloping forwards, and very slightly convex; a slight depression is seen between the pars cephalica, and the pars thoracica. The front row of eyes is seen from before, nearly straight, but slightly curved upwards; the hind row is curved forwards. The four central eyes occupy an area slightly longer than broad behind, and much broader behind than in front; the lateral eyes of either side are separated by a very distinct interval (not contiguous), and placed on a protuberance. The anterior lateral eyes are the largest of the eight, oval and obliquely posited; the anterior centrals appear to be a little smaller than the posterior eyes; they are prominent, only separated by a very small interval, and their distance from the margin of the clypeus is double as great as their diameter; the interval between them and the anterior lateral eyes is somewhat greater than the diameter of these last named eyes. The intervals between the four posterior eyes, which are very nearly of the same size, are nearly equal, and at least half again as great as the diameter of an eye. Sternum large and broad, convex towards the margins, shining, sparingly spread with fine hairs. Mandibles somewhat ovate, nearly double as thick as the fore

thighs, more than double as long as broad at the base, shining, and somewhat hairy; their back is moderately convex towards the base; their outer side is straight; on the inner, towards the apex, they are gradually narrowing, and slightly rounded; the claw furrow is armed with rather small teeth, the claw is long and slender. Maxillæ rounded on the outer side and at the apex, slightly inclined towards the labium, which is transverse and broadly truncate. Palpi provided with coarse hairs; their tarsal joint is cylindrical and obtuse at the apex. Legs slender, with rather coarse hairs; the thighs are cylindrical (not incrassated at the base above), the tibia of the fourth pair are about four times as long as the patella. Abdomen inversely ovate, shining and covered, though not thickly, with very fine hairs; the vulva consists of a shallow transverse somewhat elliptical fovea near the rima genitalis, the anterior margin of which here forms an elevated rather thick, shining costa, narrowing from the rounded extremities towards the middle, in front, and thus slightly curved forwards, and bordering the fovea behind, and on the sides; the hind part of this costa (or the anterior elevated margin of the rima genitalis), seen from behind, exhibits two small narrow transverse foveæ in front of the larger fovea; the area vulvæ is somewhat striated transversely.

Color.—Cephalathorax, sternum, lip and maxillæ black, the maxillæ a little paler. Mandibles dark yellowish, with three longitudinal black stripes. Palpi and legs of a very dull blackish yellow color. Abdomen grayish black, somewhat olivaceous on the under part; the hairs with which it is covered are olivaceous yellow. The area vulvæ is black, its hind elevated border brown.

Length of body nearly three millim.; length of cephalothorax three-quarters, of abdomen one and five-sixths millim., breadth of abdomen one and one-half millim. Legs I two and two-thirds, II nearly two and one-half, III two and one-quarter, IV nearly three and one-quarter millim.; pat. + tib. IV. nearly one millim.

A single female of this obscure species, which appears to belong to the *E. longipalpis* group, was found at Polaris Bay.

3. *Lycosa glacialis* Thor.

Syn. 1872. *Lycosa glacialis* Thor. Om några Arachn. fr. Grönland, loc. cit., p. 159.

1877. " " *Cambr.*, loc. cit. p. 281.

One adult female example from Foulke fiord.[1]

4. *Trochosa* inc. spec.

A young female of a Lycosoid which belongs, I think, to the genus *Trochosa*, was captured at Polaris Bay. The example is

[1] I take this opportunity to change the names of two North American *Lycosæ*, *L. indagatrix* and *L. impavida*, described in my paper, Descriptions of the Araneæ collected in Colorado in 1875 by A. S. Packard, Jr. (Bull. of the U. S. Geol. and Geograph. Survey, III, No. 2, pp. 512, 513), those names being pre-occupied. For *L. indagatrix* I propose the name *L. dromœa*; for *L. impavida* that of *L. tachypoda*.

very much damaged, most of the legs being reduced to fragments, and the color of the abdomen entirely lost. The foremost row of eyes appears to be slightly longer, or at least is not shorter, than the middle row; the interval between the anterior central eyes is evidently greater than the intervals between them and the anterior laterals, which appear to be slightly smaller than the anterior central eyes. The area occupied by the four posterior eyes is longer than broad in front, but shorter than broad behind; the interval between the two large eyes of the middle row is nearly double as great as their diameter; the interval between the two eyes of the hindmost row equals the length of the middle row. The cephalothorax is brown, its sides covered with coarse appressed, olivaceous-grayish hair; all along the back it has a broad paler band covered with grayish-white hair, which stretches from the middle row of eyes nearly to the hind margin of the cephalothorax, filling up the area between the four posterior eyes, somewhat dilated and rounded in the sides just behind this area, and then tapering gradually backwards. The sternum and the under side of the coxæ are brownish-testaceous, clothed with grayish hair; the mandibles are piceous, covered with coarse grayish hair at the base, black-haired towards the apex. The legs are brown, very distinctly black-ringed, covered with shorter grayish and longer black hairs. Length of the example: seven millim.; length of its cephalothorax three millim.; legs of the fourth pair eight and one-half, patella and tibia of that pair three millim.

By the form of the band along the back of the cephalothorax, as also by several other characteristics, this species would seem to be identical with *Tarentula exasperans* Cambr. (loc. cit., p. 283, Pl. VIII, fig. 7); but in that species the foremost row of eyes is said to be the shortest of the three, whereas in the spider before us the middle row is as short as, if not shorter than, the foremost. —*T. Thorell, Genoa, April* 8, 1878.

Thelyphonus Offensively Odorous.—In the *Naturalist*, XI. p. 367, the poisonous nature of the whip-scorpion (*Thelyphonus giganteus*) of Mexico and adjoining portions of the United States was described. That it emits from its "whip" an extremely offensive smell, is stated by Mr. E. Wilkinson, Jr., in a letter to the Smithsonian Institution. The animal was found under stones near Chihuahua. "After considerable difficulty," he writes, "I succeeded in capturing him, but not, however, until I had received several doses of his powerful effluvia, which obliged me each time to retreat and catch a fresh breath."

The Paper Nautilus in Florida.—It has been doubted by some naturalists whether the Argonaut, or paper nautilus, occurs on the Florida coast. Two paper shells have been found here this winter, and last winter one was found with the animal entire, besides another empty shell. Its habitat is probably in tropical

seas, but it is sometimes brought to these shores by storms. In the Indian Ocean I have seen it in calm weather sailing on the surface, as described by old writers, but discredited by closet naturalists of these days.—*S. C. C. Halifax Inlet, Florida, Feb.* 17, 1878. *From Forest and Stream, March* 21, 1878.

The *Naturalist*, Vol. XI, p. 243, contains a notice by S. Lockwood, on the occurrence of the paper nautilus on the New Jersey shore.

Buccinum undatum *Linné.*—I have received many interesting specimens of this shell from the lobster-men at this town (Stonington Conn). They were brought up from a depth of ten to nineteen fathoms in lobster-pots attached to the "bait." The shells are very fine, with apex absolutely perfect; and in nearly every instance the entire shell is heavily incrusted with *Lithothamnion polymorphum.* I have never before observed this nullipore on shells, though it is common all along this coast on rocks and stones. The incrustation has prevented the erosion of the shell and when removed discloses an almost perfect epidermis. The locality of the *B. undatum* obtained is off Stonington, at the eastern extremity of Fisher's Island, where they occur in considerable numbers. The locomotive powers of *B. undatum* must be quite remarkable, since, in one instance, a lobster-man took between thirty and forty from one pot. These, like *Ilynassa obsoleta*, are seemingly attracted, oftentimes, from a distance, by the bait in the pots.

Trachydermon (Leptochiton) ruber *Carpenter.*—Four specimens of this species were found on the *B. undatum* taken off Fisher's Island. Its natural habitat is "almost exclusively on and among rocks." Its presence on these shells may serve, in some measure, to explain their distribution. The chiton must go where the shell goes, but at any point may detach itself or be rubbed off and so become "naturalized" at that point. The chitons are on the shell, doubtless, because the nullipore with which it is incrusted forms their natural food. Their color is nearly that of the living *Lithothamnion*, though one specimen is a very dark brown. Their color is, therefore, *protective.*—*R. Ellsworth Call.*

Nesting Habits of the Canada Flycatcher.—I have submitted the eggs referred to in the "Naturalist," Vol. XI, p. 565, under the heading—"Red-bellied Nuthatch (Sitta Canadensis)? nesting on the ground," to Dr. Brewer, for examination, and after comparing them with the various similar specimens in his cabinet, he thinks that they should be referred to the "Canada Flycatcher" (*Myiodioctes canadensis*), though even then he would retain the obnoxious interrogation point, as in some respects, the described nest is much unlike the typical nest of this bird.—*Frank H. Nutter.*

DROWNED BY AN OCTOPUS.—Though in British Columbia at the time of the occurence of the incident referred to by Mr. Moseley in Nature (vol. xvii, p. 27), I was in the interior, and consequently heard nothing of the matter. On reading Mr. Moseley's letter, however, I wrote to my friend Dr. W. F. Tolmie, of Victoria, and have just received from him an account verifying in all essential particulars the extract quoted by Mr. Moseley from the *Weekly Oregonian*.

A party of Makaw or Makah Indians, of Cape Flattery, were returning from a visit to the Songish Indians of the vicinity of Victoria, and camped the first afternoon at Metchosin, on the south shore of Vancouver Island. A young woman having separated herself from the others to bathe, did not return in the evening, and after having searched for her in vain the next morning, the rest of the party were about to continue on their journey, when, on rounding the first point, they saw the body of the woman as if seated on the sandy sea-bottom, with a large octopus attached to it, which, according to the description of Dr. Tolmie's informant, resembled a "fifty pound flour sack, full." The body was rescued in the manner described in the *Oregonian*, and when brought ashore, still had portions of the arms of the octopus adhering to it.

Dr. Tolmie also mentions the case of an Indian woman at Fort Simpson, who had, many years ago, a narrow escape from a similar death; also that among the Chimsgau Indians traditions of escapes and occasional cases of drowning exist, and further, that among these people a story is current that "a two-masted vessel manned in part or whole by men, with obliquely placed eyes and wearing queues (at Milbank Sound, Lat 52°, about seventy years ago), was seized by an enormous squid, whose tentacles had to be chopped with axes ere the craft was clear of it. The ship is said to have been wrecked further south on the coast, in consequence of the evil influence of the monster."—GEORGE M. DAWSON, in *Nature*.

THE HABITS OF THE MUSKRAT.—About the middle of last November while walking along the banks of the North Fork of Sappa creek, Rawlins county, Kansas, my attention was directed to an old beaver dam that had been recently repaired by a muskrat. Mud had been placed on the dam so as to make it watertight, but so far as I could see no sticks had been brought there, excepting those used in the first building by the beaver. Some of the mud was removed so as to allow more water to escape and a trap set. The next morning the trap was sprung and the mud partly replaced. No beaver signs were to be found anywhere, while the tracks of muskrats were numerous in the mud used in repairing, and elsewhere around the dam. A trapper informed me that he had frequently observed dams that had been repaired by muskrats in a simlar manner.—*Russell Hill.*

IDENTITY OF DIEMYCTYLUS MINIATUS WITH DIEMYCTYLUS VIRIDESCENS.—Last summer I brought home from Sullivan county, Penna., a large number of specimens of *Diemyctylus miniatus* Raf., popularly called "little red lizard" or "red eft," and after keeping them in a dark box filled with moss, saturated with water, all the specimens have changed their color from bright vermilion to the olive shade characteristic of *D. viridescens*, and are in all particulars identical with the last named species. Although the specimens were kept in a moist medium, they were at no time immersed, and to make the test crucial I dropped three of them into a tub inclined at an angle with the floor and partially filled. Upon their immersion they immediately swam or wriggled vigorously for land, but after leaving the water and stopping a few seconds they turned around and walked back into the water and remained there, only coming up at intervals for air. One remained thus fifteen minutes before rising to the surface. Some hours after, upon watching them again, it was twenty minutes before one of them returned to the surface, and as the others seemed disposed to remain under a much longer time I was obliged to leave them. These specimens have been kept in the house all winter and are almost as lively as those I watched at the bottom of the lake in the summer. This morning I agitated the water with the tips of my fingers, and, upon attracting their attention, saw two of them gulp down two pieces of raw meat. Nothing could more satisfactorily demonstrate their entire satisfaction with the element in which they had been newly placed. The conclusion then is that instead of two well marked species, *D. viridescens* and *D. miniatus*, or of a species and a variety, we have but a single species *Diemyctylus miniatus*.

Dr. Hallowell was the first to express his belief that these so-called distinct species were the same (Proc. Acad. Nat. Sci. Phila., Feb. 1856). This was followed in April, 1859 (Proc. Acad. Nat. Sci. Phila)., by the statement made by Prof. Cope, after detailing the synonyms of *D. viridescens*, "We include in the above synonyms those of the nominal species *D. miniatus*, which we think with Dr. Hallowell is a state of *D. viridescens*." In the Proc. Boston Soc. Nat. Hist., Prof. Verrill's remarks, respecting *D. miniatus*, "I cannot agree with Prof. Cope in regarding this as a form of *D. viridescens*."—*Howard A. Kelly.*

AN EARLY BIRD INDEED.—On March 21st I was shown a chipping sparrow's nest (*Spizella socialis*) in the midst of a strawberry bed on the farm of Mr. John P. Sanborn, near the city of Port Huron, Michigan, in which were three newly-hatched little ones and an egg. Such an occurrence, *even in the middle of April*, is unprecedented in this latitude. Robins appeared February 11th, bluebirds February 18th, blackbirds, song sparrows and golden-winged wood-peckers observed February 22d, bob-o-links March 2d, martins March 3d.—*G. A. Stockwell, M.D., Port Huron, Mich.*

ANTHROPOLOGY.[1]

LANGUAGE MAP OF AMERICA.—In the *Geographical Magazine* for March, 1878, the statement is made that Mr. A. H. Keane is collecting materials for a language map of America. We cannot speak from personal experience concerning the difficulties of such an undertaking for South America; but we can assure any one who attempts the task for North America that the impediments are almost insurmountable. The Smithsonian Institution has for twenty-five years zealously collected vocabularies and other linguistic material. These have all been placed in the hands of Major J. W. Powell, who has called to his aid most of the eminent philologists of our country in adding to and perfecting what has been already gathered. The first volume of "Contributions to American Ethnology," already published, is the harbinger of a series which, when completed, will exhibit the linguistic geography of our aborigines. Dr. Berendt is doing similar work for Middle America.

THE DAVENPORT TABLET.—With respect to the Davenport tablet, concerning which a mild caution was ventured in the May NATURALIST, Mr. J. Duncan Putnam, corresponding secretary of the Davenport Academy, writes: "This tablet was found by Mr. Gass, and is believed to be just as genuine as those found a year ago, and they appear to be just as genuine as the copper axes, stone pipes, sea shells, etc., found along side of them. They may be all "got up," but if so the evidence is very strong that they were not done by any "wag" of the present generation. A full account of this last find will be printed in our next number of *Proceedings*, now in press."

ANTHROPOLOGICAL NEWS.—The Rev. Stephen Bowers is lecturing in the western cities upon Explorations in Southern California. The labors of Mr. Bowers were confined to that portion of the state bordering on the ocean, and to the Santa Barbara islands. His contributions to the National Museum equal in value and number those of any of its numerous friends.

MR. J. D. McGUIRE, of Ellicott city, Maryland, in a letter to the Smithsonian Institution, speaks of a number of arrow-heads in his possession whose points have been polished apparently by design. As this is the first allusion to the subject of polished quartz arrow-points, the discovery of Mr. McGuire is very interesting. If the same phenomenon has been observed elsewhere we should be glad to know it.

THE Annual Report of the secretary of the Smithsonian Institution contains a detailed account of a forthcoming publication from the pen of Dr. Habel concerning the discovery of sculptured slabs at Santa Lucia Cotzumalhuapa, near the city of Gua-

[1] Edited by Prof. OTIS T. MASON, Columbian College, Washington, D. C.

temala. Several years ago Dr. Habel resigned a lucrative medical practice in New York to visit Central America. While in Guatemala he came upon these interesting remains which he cleared away at great expense of time and labor, and the sculptures of which he copied with the greatest accuracy. These slabs resemble the best sculptures of Mexico and Central America in the objects represented, and in the barbaric exhuberance of ornament. There are two features which are almost unique, the symbol for speech, and for numerals. The speech symbol consists of a vine-like ridge proceeding from the mouth or neck of the suppliant or of the divinity and winding about in various shapes. The staff or ridge is adorned with nodes and trefoils in such positions and groups as to give great plausibility to Dr. Habel's belief that the ornamented staff indicates the very desire or thought of the speaker. The numeral symbol consists of rows of rings accompanied by parallel and cross lines. The beauty and uniqueness of these sculptures will make Dr. Habel's paper one of great interest and value. The slabs were purchased, subsequently to Dr. Habel's visit, by Dr. Bastian, and will be removed to Berlin.

The *Archiv für Anthropologie*, part 4, for 1877, is one of the most valuable numbers of that periodical which have appeared. In addition to the usual amount of original matter, an account of which will be found below, a series of papers is commenced entitled, "Die anthropologischen Sammlungen Deutschlands: ein Verzeichniss des in Deutschland vorhandenen anthropologischen Materials nach Beschluss der deutschen anthropologischen Gesellschaft zusammengestellt unter Leitung des Vorsitzenden der zu diesem Zwecke ernannten Commission." The first paper of 68 pages is devoted to the anthropological collection of the anatomical museum of the University of Bonn, and contains the description of 446 human and simian skeletons and skulls. The papers are so arranged that they can be detached from the *Archiv* and subsequently bound in a separate volume. It makes one sigh for the spirit of Jeffries Wyman to think how little the anatomists of our country are doing with the rich material scattered on every hand.

The following papers have come under our notice: Der Nachfolger des Onondaga-Riesen, C. Rau, *Archiv*, vol. x, No. 4; Prehistoric Ruins in Dade Co., Missouri, *Western Review*, April; The Blackwater, Missouri, Mounds, *id.*; Soapstone Quarry in Providence county, R. I., *id.*; L'ancienneté de l'homme au Mexique, *La Nature*, March 23d; Brandsford's Ausgrabungen auf Ometepec, *Globus*, xxxi, No 21; Die Mineralogie als Hülfswissenchaft für Archäologie, Ethnographie, u. s. w., mit specialler Berücksichtigung mexicanischer Sculpturen, II, H. Fischer, *Archiv*, x, 4; Lebensweise und Geräthe der süd-chilenischen Indianer, *Correspondenzblatt*, 1878, I.

Foreign papers of general interest are: Finländische Archäologische Literatur von 1745 bis heute, Dr. J. R. Aspelin in Helsingfors, *Archiv*, x, 4; Mittheilungen aus der Anthroplogischen Literatur Belgiens im Jahre 1876, Prof. L. von der Kindere, Brüssel, *id.*; Mittheilungen der russischen Literatur über Anthropologie, Dr. Ludwig Stieda, *id.*; Archæological Researches at Carnac, in Brittany, James Miln (David Douglas, Edinburgh); Ueber die achte Jahresversammlung der deutschen anthropologischen Gesellschaft, Graf Wurmbrand, *Mittheilungen* der Anthropologischen Gesellschaft in Wien, 1877, 10; Ueber neue Ausgrabungen auf den alten Gräberstätten bei Hallstatt, Dr. Ferd. von Hochstetter, *id.* 11; Zur Ethnographie Noricums, Dr. Fligier, *id.* 10 (a very scholarly paper made more valuable by the abundance of references to authorities); Die Ethnographie der Balkan-Halbinsel im 14 und 15 Jahrhundert, Prof. G. Hertzburg, Petermann's *Mittheilungen*, 1878, iv; Die Anfänge des Staats-und Rechtslebens, *Das Ausland*, April 1st; Growth of Ideas and Customs, E. B. Tylor, a lecture before the London Institution April 11th; Die Urgeschichte der Menschheit, Otto Caspari, 2d edition, Leipzig; On the Human Hair, Prof. Schwalbe, *Correspondenzblatt*, 1877, 2; On the Influence of Climate upon the Development of Art, especially Architecture, Prof. Portlage, *id.*

Indian Food Customs.—When an Indian is out of food he goes to those who have plenty, and it is considered a breach of etiquette not to feed the hungry. The provident are often imposed upon in this way. The Indians think it very strange that some whites have a superabundance of food while others have none at all. The females provide most of the food. They are the gatherers of nuts, seeds, roots and fruits, and convert them into bread and mush, while the men provide the meat. The labor of collecting these vegetable products is very great, the women being compelled to wander miles from their homes to obtain them. They are often seen on their homeward march with astonishing loads, so bulky at times as to conceal them entirely. They wander about all day in the grain fields picking up head by head until they have secured a load. A merchant of Tucson informed me that he had bought from some Papago women three sacks of wheat secured in this manner. The Indians formerly made two kinds of bread, one is a small flat cake or biscuit baked in the ashes, the other is as thin as a wafer, and made in the following manner. Meal or flour from any native product is mixed with water and a little salt to the consistency of dough. The cook then takes a piece in her hand, pulls it and flattens it out until a large, thin, round cake is formed. This is baked on a flat, hot stone, first on one side and then on the other. Much of their flour and meal is eaten as mush or gruel, which they relish very much.—*Edward Palmer.*

FISH-HOOKS OF THE MOHAVE INDIANS.—Questioning some old Indians about their native fish-hooks, I found that they used the spine of a cactus for this purpose. Having made a bargain with one to allow me to see him make the hooks, he returned in a few hours with a plant and a number of the spines of *Echinocactus wislizeni*. He commenced by placing the spines in water for a short time in order to render them pliable, at the same time wrapping the thumb and first finger of his right hand with rags. He then made a small torch about half the size of one's little finger by twisting some pieces of rags together rather tightly. Selecting a spine from the water and placing it between the ends of the wrapped thumb and finger, the torch was lit and held in the left hand close to the spine, the workman dexterously changing the position so as to impart the same amount of heat to all portions at once. Occasionally he moistened the spine in his mouth. By this application of heat and moisture he tempered the spine, and at the same time applying a gentle pressure by the end of the wrapped finger he was soon able to produce a very fair and strong hook. As soon as a sufficient curvature is obtained, it is secured by fastening a string from the point to the shaft.

The fish of the Colorado river, eaten by the Mohaves, do not nibble the bait, but bolt it, hook and all, and are killed by the wounds which are made in their gills. This cactus-spine hook would be of no use in catching fish that nibble, as there is no barb. The Indians fasten the bait below the hook, before throwing it into the water. The iron hooks obtained from the whites now take the place of their old-fashioned ones.—*Edward Palmer.*

INDIAN STEATITE DISHES.—A very interesting discovery has recently been made by Mr. H. N. Angell, of Providence, R. I., showing how the Indians formerly manufactured steatite dishes. As he was quarrying about a ledge of rocks near his home, early in the month of February, he came upon a bed of soapstone, which bore evident traces of having at one time been artificially worked. Cart loads of steatite dust and chippings were removed before the ledge could be uncovered, when it presented a very peculiar appearance, being covered by protuberances and depressions. A number of finished vessels were obtained and many more in a partial state of completion. The pots were first rudely carved out of the rock with slate or stone knives and chisels, bottom-side up, and were then removed from the mass by inserting wedges beneath them, after which they were hollowed out. Mr. Angell states that "the soap-stone bed, as now uncovered, is about 30 by 90 feet in extent, and all of the surface has been worked. We found by excavating in other places in the vicinity, stone hammers, chisels and sledges that will weigh from 50 to 150 pounds. We also found a rudely wrought stone which resembles a plough and which will weigh over 100 pounds." The

bed of steatite had been lowered several feet by the removal of the stone, and it is certain that great numbers of vessels were fashioned at this quarry.—*E. A. Barber.*

Surgeon John H. Janeway has presented to the Army Medical Museum five crania from the shell-heaps near St. Augustine, Florida. These crania are especially remarkable for the position, shape and size of the foramen magnum, and for the great size of the basilar process, occasioned by the extremely backward position of the foramen magnum. The museum has also received from Second Lieutenant C. A. H. McCauley a cranium from the ruins of Mesa Morasis, on the Rio de los Animos, near its mouth. This is the fourth cranium from these cliff structures, furnishing a good beginning for a comparative study. It is to be hoped that this splendid collection, now under the charge of Dr. Otis, will be fostered by anthropologists in all parts of our country. The Quartermaster's Department have orders to transmit all specimens to Washington, free of charge.

Mr. Spofford, of the Congressional Library, is now publishing a complete catalogue in one alphabet of everything in the library, with titles complete, including the Smithsonian additions, under the names of societies.

In the *Magazine of American History* for February, Dr. Charles Rau publishes the paper on the Dighton Rock Inscription which he read before the American Anthropological Society last September.

Mr. E. A. Barber communicates the fact that in the "Museum of the Pennsylvania School of Industrial Art," in the Memorial Hall, Philadelphia, is a collection of relics from the Swiss Lake Dwellings. We shall be glad to publish the location and special character of public and private collections of merit in our country.

The following works and papers have appeared: Mound Explorations in South-eastern Missouri (in Madrid county), by C. Crosswell, Trans. of the Acad. of Sciences of St. Louis, Vol. iii, No. 4; Antiquity of Caverns and Cavern Life in the Ohio valley, by Prof. N. S. Shaler, Boston Soc. of Nat. History; Les Esquimaux (based on the presence of a group of them in the Jardin d'Acclimation de Paris), *Révue Scientifique*, Jan. 26th; Colored People considered scientifically and socially, by D. H. Jacques, *Phrenological Journal*, Dec.; The Southern Negro as he is, by George R. Stetson (A. Williams & Co.); Cuban Antiquities: the Caneys of the Dead, by Antonio Bachiller, *Magazine of American History*, Dec.; The Second Conquest of Peru, by C. P. Mackie, *Penn Monthly*, Feb.; Pottery: How it is Made, by George Ward Nichols (G. P. Putnam's Sons); A Hand-book of Ceramic Art, by M. S. Lockwood (*id.*); Bibliotheca Americana, by Robert Clarke & Co., Cincinnati.

Foreign.—An interesting course of lectures has been inaugurated in connection with the new museum of ethnography at Paris.

Nearly every afternoon is appropriated to a discourse by some eminent savant on topics illustrated by the collections in the museum.

The German Emperor has presented to the ethnographical department of the Royal Museum at Berlin, a collection of weapons from Java, Sumatra, Borneo, Celebes, Flores, Amboyna and other islands, made by Herr Erdmann, German Consul at Samarang, Java.

On Friday, February 15th, the Rev. W. E. Cousins read a paper before the London Philological Society on Malagasy, the language of Madagascar, a short sketch is given in *The Academy* for March 2d.

Dr. Stuart Eldridge sends a copy of his pamphlet on the crania of the Botans of Formosa, read before the Asiatic Society of Japan, March 14th, 1877. The first few pages are occupied with a résumé of the science of craniology. The researches of Dr. Eldridge were made on four skulls. The Botans, or Motans, are one of the aboriginal tribes of Formosa, having a fine physical development, and distinguished by the following characteristics: They are courageous, frank and impressible; straight haired; complexion varied, but always of a brown tint, never black; having some knowledge of agriculture, cultivating tobacco, root-crops and rice; domesticating buffaloes, pigs, dogs and poultry; living under a patriarchal organization; fond of the chase; having some slight knowledge of certain arts, and a rude form of religion, the cultus of which is, at least to some extent, in the hands of priestesses who are highly reverenced. There are no signs of artificial distortion in any of the skulls; when held at arm's length the malar bones are visible on either side, and all are dolichocephalic. In all, the upper edges of the zygomata are somewhat convex, the temporal ridges are strongly marked, the processes are highly developed, the mastoids are about the average, the external auditory foramina are oval, the arch of the palate is low and flat, the external opening of the nose is large, the frontal sinuses are small, and the ethmoidal ridge of the frontal large and prominent. They are almost uniformly orthognathous. The orbits in Nos. 1 and 3 are somewhat square in outline, while in No. 2 the orbit is elliptical, the axis being directed downward and outward. The occipital foramina of Nos. 1 and 4 are rather more oval than common, those of Nos. 2 and 3 being about normal in shape. The sutures of Nos. 1, 2 and 4 are distinct and ununited. In No. 3 all the sutures save the squamous and a part of the lambdoidal are obliterated. The pamphlet closes with a tabular view of the measurements of the skulls according to the scheme of Huxley, from which a few are extracted: Length 7, 6.95, 7.15, 7.02 inches for the four skulls respectively; breadth 5.45, 5.35, 5.38, 5.28; height 5.30, 5.27, 5.52, 5.26; cephalic index .78, .77, .75, .75; facial angle 76.3°, 80.5°, 84.3°; capacity 84.82, 91.34, 83.43, 75.90 cubic inches.

GEOLOGY AND PALÆONTOLOGY.

A NEW OPISTHOCŒLOUS DINOSAUR.—I have recently received from the Dakota beds of Canyon city, Colorado, a number of bones of a new and remarkable extinct reptile allied to *Camarasaurus* (= *Titanosaurus* and *Atlantosaurus* Marsh nom. nud.), and *Streptospondylus*. The dorsal vertebræ are strongly opisthocœlous, and are without lateral fossa or foramen of the centrum. The arch is freely articulated with the latter, and is not much elevated, and possesses no hyposphen. The neural spine is transverse; the diapophysis is supported on narrow buttresses, and the neural arches generally lightened by fossæ as in the two genera named. A strong parapophysial tubercle near the anterior convexity receives the head of the rib. Each zygapophysis of one side is separated from that of the other by a deep concavity. The genus so characterized may be called *Epanterias*, and the species *E. amplexus*. The latter has a rather low and wide dorsal neural arch with small fore and aft diameter, and with a neural spine divided into three obtuse apices. There are three fossæ at the base of the diapophysis, the anterior one vertical; and a very deep one between the posterior zygapophyses. The cup of the centrum embraces the ball extensively, and the neurapophysis overlaps the side of the centrum behind. Length of centrum m. .115; diameters behind, transverse, .120; vertical .108. Elevation of neural arch .290; width of neural spine .083, of both diapophyses .400. This saurian was much smaller than the *Camarasaurus supremus*, and perhaps equal to the *Hadrosaurus foulkei*. It may be associated with the former in the *Camarasauridæ*. With *Amphicœlias* is probably in like manner to be arranged *Tichosteus;* while the carnivorous form *Hypsirhophus* represents a third type.—*E. D. Cope.*

PROF. MARSH ON PERMIAN REPTILES.—In the May number of the *American Journal of Science and Arts*, there is an appendix added by Prof. O. C. Marsh, in which he characterizes in a very insufficient manner, four species of reptiles, which he states to have been derived from a Permian formation in New Mexico. We should not regard this article as suitable for notice in this journal but for certain assertions which it contains, and some circumstances connected with its publication. In the opening paragraph it is asserted that "hitherto no Permian vertebrates have been identified in this country, although not uncommon in Europe." This statement is the reverse of the fact. In the Proceedings of the Philadelphia Academy for 1875, p. 404, a paper on this type of vertebrates commences, where some of the leading characters of the reptiles are pointed out. In the Proceedings of the American Philosophical Society for May, 1877, several new species are described from the same formation, and in the same journal for November, 1877, other species are added, making the whole number up to twenty-one. These

papers Prof. Marsh has had the opportunity of seeing. Two further notices of the vertebrates of the American Permian appeared on April 22d of the present year, in the May number of this journal, pp. 319, 327. As the corresponding number of the *Amer. Jour. Sci. and Arts* was not issued before May 5th (perhaps a day or two sooner), Prof. Marsh had the opportunity of seeing these also. They include references to seven new genera, for most of which the characters are clearly pointed out.

The features common to the genera of the Permian, described by Marsh, are stated by him to be those characteristic of the order *Rhynchocephalia*; as I have already shown to be the case with the forms described by me in the earliest as well as later papers of those cited. Another characteristic is said to be the presence of the intercentrum, a statement agreeing with my own in the May number of this journal. It is also observed that there is a double tubercular rib-articulation of the centra, a structure I have already described in the genus *Diplocaulus*.[1] Prof. Marsh's statement that the mode of implantation of the teeth is similar to that of the "*Mosasuria*" is probably incorrect.

As the author of the paper does not think it necessary to allude to published sources of information, it is too much to expect him to give credit for ideas communicated to him verbally. *All* of the above mentioned, and additional characters cited by Marsh in his two opening paragraphs[2] (l. c. 409) as belonging to the Permian Reptiles, with others, were explained by me before the National Academy of Sciences, with Prof. Marsh as an attentive listener, at its last meeting in Washington, April 18th, more than two weeks before the appearance of the paper here criticized. The characters to which I refer are "the separate premaxillaries, the immovable quadrate, and the biconcave vertebræ;" the "hypaxial elements of the vertebræ called by [von Meyer] intercentral bones." "These intercentral ossifications apparently exist in all the Reptilia yet found in this new fauna." Compare these statements with those found in my paper read before the National Academy (which had been previously read before the American Philos. Society, April 5th) and published May 8th. That Prof. Marsh profited by what he heard, is evidenced by his use of the term "intercentra," first introduced by myself. From this point of view it is easy to understand his attempt to make it appear that Meyer first used the word. He says, "Another character of much interest is the presence of certain hypaxial elements of the vertebræ, first observed by von Meyer in the Triassic genus *Sphenosaurus*,[3] and called by him intercentral bones ('*Zwichenwirbelbein*')" (sic). As *Zwischenwirbelbein* does not mean intercentrum, but *interver-*

[1] Proceed. Amer. Philos. Soc. 1877, p. 187.

[2] Except that mentioned previously under *Diplocaulus*.

[3] Which I referred to the *Rhynchocephalia* in 1870; see Proceed. Am. Ass. Adv. Sci. xix, p. 242.

tebral bone, Prof. Marsh's knowledge of the former term must be ascribed to some other source. The fact that the Amer. Journ. Sci. Arts appeared a good deal later than its usual date of publication, may be considered in this connection.—*E. D. Cope.*

Fossorial Reptiles.—Prof. Cope has recently described some reptiles from the Permian formation in which the humeri possess many of the characters of those of the mole and other fossorial *Mammalia* in the great development of the muscular insertions and epicondyles, and the presence of a supracondylar foramen. They are referred to five species of three genera of *Pelycosauria*, a tribe of the order *Rhynchocephalia*.

GEOGRAPHY AND TRAVELS.

Richthofen's China.[1]—The portion of this great work relating to the loess, so wonderfully developed in parts of China, was noticed, at some length, by Prof. Whitney in the December number of this journal. We will merely run through the table of contents, to show the breadth of the researches made by the learned author, so well known in this country for his investigations in the geology of California. The general features of China and Central Asia, the loess formation in Northern China, the structure and formation of the salt steppes of Central Asia are discussed at length. This portion is followed by chapters on the transition region of Central Asia, on the distribution of desert and loess-covered regions in other parts of the earth; the plateaux of Central Asia, embracing the Tiën-shan, Kwen-lun and the mountainous regions in Southern Asia. The second part relates to the development of our geographical and historical knowledge of China. The wood-cuts are in many cases full-page illustrations and, with the maps and general elegance of the typography and paper, in addition to the text, render the work of a high order of interest.

The Big Horn Cañon.—Gen. Brisbin has given an interesting account of the Powder river country, extending from the sources of the Big Horn and Powder rivers over the Big Horn mountains and the plains as far as the Missouri river, a country unknown to white men until 1866. "It contains," says Judge Daly in his recent address to the American Geographical Society, "one of the greatest natural curiosities of our continent, the Big Horn Cañon, which rivals the famous gorge of the Colorado."

The Isthmus of Darien.—A valuable map and notice of recent surveys, especially those of Lieut. L. N. B. Wyse in 1876

[1] *China. Ergebnisse eigener Reisen, und darauf gegründeter Studien.* Von F. T. von Richthofen. Eister Band. Einleitender Thiel. Mit 29 wood-cuts and 11 maps. Berlin. D. Reimer. 1877. 4to, pp. 758.

and '77, appears in the *Geographical Magazine* for April. Lieut. Wyse reports that a canal directly up the valleys of the Jupisa and Jiati is feasible, and recommends this route. He pays a just tribute to the work done by his predecessors, Commanders Selfridge and Lull, of the U. S. Navy. Farther explorations were carried on the past winter by Lieut. Wysė.

GEOGRAPHICAL NOTES.—The *Geographical Magazine* for April contains a colored map, giving the proposed changes in the territorial boundary of European Turkey, as stated in Articles I, III and VI of the preliminary treaty of peace. Mr. J. Boyer has lately ascended Mount Ararat, which is 17,000 feet high. Large beds of snow extend down to a height of 11,000 or 12,000 feet. The last part of the ascent was upon a slope of rotten rock, which crumbled under foot, making the ascent very fatiguing. He found not a fragment of Noah's Ark.

MICROSCOPY.[1]

A NOVEL STAND.—A microscope stand, recently made for Dr. Blackham, of Dunkirk, by Mr. Tolles, of Boston, combines with the usual excellencies of that maker's work, some peculiarities designed to fit it especially for optical experiments. The stand is made on the Jackson model, and the slide behind the body, by which focal adjustment is made, is furnished with a scale and vernier by which the working focal distance of the objectives used can be measured with facility. Dr. Blackham claims this device as his own, though the claim has brought to light representations that the device has been previously used or suggested by Mr. Geo. E. Fell, of Buffalo. The most conspicuous peculiarity of the instrument is the method of mounting the mirror and sub-stage. Back of the stage and between it and the curved arm that supports the body, is a brass disc three-tenths of an inch thick and nearly five inches in diameter. This disc is arranged vertically between the body and the curved arm, with its center in the horizontal plane of the object. On the face of this plate, and near to its circumference, is a deep circular groove in which slides a radial arm which bears the sub-stage, mirror, etc. This gives, with great smoothness, the rotation of all the sub-stage apparatus around the object on the stage as a center. Though made last year, Mr. Tolles claims that this expedient was designed by him in 1871, thus anticipating the introduction of similar devices by other inventors during the last few years.

MICROSCOPICAL SOIRÉE.—The State Microscopical Society of Illinois held its annual soirée, by invitation, at the residence of Mr. E. W. Blatchford, at Chicago, on the 8th of March. This *conversazione* was one of the most notable scientific events that have ever occurred in the city. Though given in the name of the

[1] This department is edited by Dr. R. H. WARD, Troy, N. Y.

State Society, the invitations were not limited to its members, the spacious residence being so thronged during the evening that fully 700 people are believed to have participated in the reception. Among the guests were many of the leading citizens of the town. Over fifty microscopes were in use, on tables distributed through a number of rooms, the whole house being given up to the entertainment. The arrangements were under the direction of Messrs. Henry W. Fuller, president, H. F. Atwood, secretary, and B. W. Thomas, treasurer of the society, assisted by Prof. S. H. Peabody, of the Academy of Sciences. A well-selected variety of popular objects was shown by members of the society, including some that are seldom used at public exhibitions on account of their difficulty—Mr. B. W. Thomas showing under two binoculars the circulation in both the tongue and the lungs of the frog. In addition to the instruments owned in the city, a variety of Beck and of Gundlach microscopes were loaned to the society by Messrs. Walmsley and Bausch & Lomb. Variety was contributed to the entertainment by experiments with electricity and the telephone. Both socially and scientifically the reception was most creditable and encouraging to the society.

Microscopical Society Elections.—The biological section of the Indianapolis Lyceum of Natural History was organized Feb. 28, 1878, the first officers being Henry Jameson, M.D., president, and W. Webster Butterfield, M.D., secretary. Meetings occur on the first Tuesday evening of each month.

The State Microscopical Society of Illinois, at its annual meeting held April 26th, elected the following officers: President, Henry W. Fuller; vice-presidents, Harvey M. Thompson and H. F. Atwood; secretary, Prof. S. H. Peabody; corresponding secretary, James Colgrove; treasurer, B. W. Thomas; trustees, Prof. E. S. Bastin, Dr. Lester Curtis, E. W. Blatchford, Samuel J. Jones and W. H. Summers.

At the annual meeting of the American Microscopical Society of the city of New York, held Tuesday evening March 26, 1878, the following officers were elected for the ensuing year: President, John B. Rich, M.D.; vice-president, Wm. H. Atkinson, M.D.; secretary, O. G. Mason, Bellevue Hospital; treasurer, T. d'Oremieulx; curator, John Frey.

Microscopical Congress.—The invitation to the Microscopical Congress at Indianapolis, next August, has been accepted by a number of societies as well as prominent workers with the microscope, and the meeting promises to be large, and most interesting to those who participate. Particulars in regard to the arrangements will be ready shortly, and can be obtained, in form of a circular, by addressing Dr. W. W. Butterfield, Indianapolis, Indiana.

Ernst Gundlach.—This well-known optician, who has been with the Bausch & Lomb Opt. Co., during the past two years,

announces his withdrawal from that company and his establishment of a factory in Rochester, in his own name, devoted entirely to microscopical work. He offers stands, with all his former improvements and with some minor advantages now added, and objectives of increased angle and reduced price. His higher powers will be on the four-system plan, and claim the excessive aperture of 150 degrees in water.

EXCHANGES.—Isthmia nervosa, rich specimens *in situ* on algæ, in exchange for any good mounted objects. M. A. Booth, Longmeadow, Mass.

Leaves with very beautiful stellate hairs and also a variety of marine objects, from the Bahamas, in exchange for mounted or unmounted objects. C. C. Merriman, Rochester, N. Y.

WANTED—Some well posted diatomist to give the names of diatoms, arranged, on a few slides, in exchange for the slides. C. M. Vorce, Cleveland, Ohio.

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SCIENTIFIC NEWS.

— Science in America has met with an irreparable loss in the death of the honored and revered Prof. Joseph Henry, secretary of the Smithsonian Institution since 1846, and president of the National Academy of Sciences. He was born in Albany, N. Y., December 17, 1797, and died May 13, working at his post, engaged, until a few days before his death, in arduous and responsible duties. We have but space, at this time, to record briefly the decease of this eminent investigator and able administrator.

— In a recent letter from Edward Desor, of Neuchatel, Switzerland, he states "that he has been diverted from his ordinary pursuits by that mischievous beast which has invaded us from North America, viz: the *Phylloxera*. We have some hope that we shall succeed in getting rid of him by means of a new treatment of the infested viper, viz: by *liquid* sulphurous acid, which has been applied recently with success at Geneva. Besides that I am prosecuting my investigations on some geological and pre-historical problems, especially the cups and archaic signs on the erratic boulders."—*F. V. H.*

— The Annual Report of the Vienna Imperial Geological Institute shows that the usual activity pervades this model institution. Additions to the special map of the empire have been carried on in the Central Alps, and from the Alps to the Venetian plain, as well as in Eastern Galicia, North-eastern Hungary and the Dneister region, while still other local surveys have been carried on in Austria. Collaberation with other geologists in Bohemia and Hungary has gone on, while the museum and library have been re-arranged in part, and heavy accessions made. (From a letter to Prof. F. V. Hayden by Count Marschall.)

— In a late number of Schultze's Archiv für Mikroskopie, Dr. A. Stecker describes the origin of the germinal layers in the chilognathous myriopods (thousand-legs). Oscar Schmidt describes the larval stages of two sponges (*Ascetta primordialis and clathrus*). W. Breitenbach describes some peculiarities in the maxillæ or tongue of *Vanessa* and *Catocala* sp., *Egybolis vaillantina* and an Australian moth allied to Ophideres, as well as the latter genus also, whose maxillæ are armed with stout spines.

— A good deal of fear and a stoppage in the sale of the shad in New Jersey and New York, has been occasioned by the discovery of ascarid worms about an inch in length occurring in the flesh and on the gills of these fish. On examination of specimens sent us by Mr. Apgar of Trenton, we find that the worms belong to *Ascaris*, or a closely allied genus. They are closely related to the ordinary ascarid or round worms which are abundant in the intestines and flesh of the cod, hake and haddock, and which we have always supposed to be rarely if ever injurious. Cases of sickness supposed to be due to the shad-worm have been reported in the papers, but it is doubtful whether any disease would show itself in so short a time. Similar, but much larger worms are common in the intestines of man and the domestic animals.

— Professor C. Semper of Würzburg, Germany, is desirous of obtaining specimens of North American salamanders, newts, hellbenders, mud-puppies or "fish-on-legs," *alive*, for use in his laboratory. Any specimens collected should be sent alive packed in wet moss, to Mr. Elmenhorst, care of Messrs. Matthiessen, Wiechers & Co., Jersey City, New Jersey, who will take them in charge and forward them to Hamburg.

— We have seen specimen copies of *Naturen*, an illustrated Norwegian monthly journal of the size of the English *Nature*, edited by Hans H. Reusch, and published at Christiania, Norway. It is devoted to the natural and physical sciences, is fully illustrated, and well supported by the leading Norwegian scientists.

— Butler University Scientific Expedition and Summer Tramp, will leave Indianapolis, June 20th, going by rail to Livingston, Ky., then on foot via Rock Castle River, Wild Cat Mountain, Cumberland Gap and Clinch Gap to Morristown, Tenn., exploring the caves and seining the rivers; thence up the Big Pigeon River, over the Great Smoky and Great Balsam Mountains, summits higher than the White Mountains and far more beautiful and wild; thence over the mountains of Chilowee and Nantahala (see Christian Reid's "Land of the Sky") up the Little Tennessee River to Estatoah Falls, through Rabun Gap to Tallulah Falls, the wildest and most beautiful series of cascades east of the Rocky Mountains. At Toccoa Falls, Georgia (about July 17th), the party will divide, a portion "marching through Georgia" to collect fishes, the others remaining in the mountains, returning

as they please. Objects: Natural History, Health and Scenery. Full instructions in Field Geology, Zoölogy, Botany. The two previous trips have been eminently successful, forty species of animals new to science having been obtained. For account of the last see *Harper's Magazine* for March. Tuition, $15.00. Board, $1.00 per day (average). Total expenses about $70. Eastern students join at Morristown. Address, Prof. D. S. Jordan, A. W. Brayton, C. H. Gilbert, *Directors*, Irvington, Ind.

— Judging by its bulletin for 1877 the Minnesota Academy of Natural Sciences is in a very flourishing state. Following the address of the President, Hon. R. J. Baldwin, is an essay on the Mycological flora of Minnesota, by Dr. A. E. Johnson, comprising 100 pages; a report on ornithology, by P. L. Hatch, M.D.; an article on Tornadoes and Cyclones, by Gen. T. L. Rosser, and the report of the Curator, A. F. Elliott.

— Prof. C. V. Riley, chief of the U. S. Entomological Commission has been appointed Entomologist to the Department of Agriculture. The fitness of the selection is manifest, and new energy and scientific activity will be infused into this important branch of applied science.

— Arrivals at the Philadelphia Zoölogical Garden: 1 ruffed grouse (*Bonasa umbellus*), purchased; 8 garter snakes, (*Eutænia sirtalis*); 2 water snakes (*Tropidonotus sipedon*), presented; 1 common bittern (*Botaurus minor*), presented; 1 red fox (*Vulpes fulvus*), presented; 1 rufous rat-kangaroo (*Hypsiprymnus rufescens*), born in the Garden; 1 gray fox (*Vulpes virginianus*), presented; 2 horned toads (*Phrynosoma cornutum*), presented; 1 cat bird (*Mimus carolinensis*); 1 robin (*Turdus migratorius*); 1 kingfisher (*Ceryle alcyon*), presented; 1 pied-billed Grebe (*Podilymbus podiceps*), purchased; 1 pinche monkey (*Midas œdipus*), presented; 1 Virginia deer (*Cervus virginianus*); 1 great kangaroo (*Macropus giganteus*), born in the Garden; 2 chimpanzees (*Anthropopithecus niger*), purchased.—*Arthur E. Brown, Gard. Supt.*

— The Smithsonian Institution is at present engaged in the preparation, for exhibition in the National Museum, of a series of plaster casts of American reptiles taken from the living or recently dead specimens, and carefully colored from nature. For this purpose it respectfully invites contributions of the following objects:

First. Specimens of any of the turtles and terrapins found in your vicinity, with information as to whether the collection embraces all the species known; and, if not, whether others may be looked for hereafter.

Second. The largest procurable specimens of serpents, with the exception of the poisonous kinds (such as rattlesnakes, copperheads, and moccasins), in reference to the transmission of which, further and special correspondence is requested.

Third. The various kinds of salamanders, water-lizards, or

ground puppies, to include the large hell-bender of the western waters; the mud pup or water-lizard of the northern lakes, or *Menobranchus;* the congo eel or ground puppy (*Siren* and *Amphiuma*) of the southern rice-fields, etc., as well as the smaller kinds found in damp places under stones and logs. A series of the frogs will also be acceptable.

All these animals should be suitably boxed and transmitted, as far as possible, alive; or, if dead, packed in ice, so as to insure their coming in good condition. The serpents require no special precautions in the way of packing; if of nearly the same size several may be sent together. If the disproportion be very great, there is, however, danger that the larger may devour the smaller. No rattlesnakes, copperheads or moccasins should be transmitted. The turtles should be wrapped or sewed up in some kind of cloth, so as to prevent friction. They should not be sent loose with the softer objects. Serpents require no moisture; frogs and salamanders should be packed with wet moss. Among the turtles should be included the soft-shell species, the true terrapins, the land tortoises, etc. Single specimens of any living reptiles, as well as larger numbers, including duplicates, will always be gladly received, and due acknowledgment made for the same. The largest procurable representatives of each species is desirable. Transmissions may be made by any express company, freight to be paid in Washington. Address the Smithsonian Institution.

— Prof. Semper during his late visit to the United States gave us the following recipe for a writing fluid for labels for alcoholic specimens. Use India ink dissolved in strong acetic acid; write and let it dry. It will stand for years.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Appalachian Mountain Club, Boston.—March 13. Prof. Edward S. Morse gave an account of a mountain excursion in Japan, adding incidentally much information in regard to the manners and customs of the people of that country. The recital was listened to with close attention, and Prof. Morse then answered many questions propounded by those present. A recess was taken to permit the club to reorganize as an incorporated body. Prof. Niles was chosen temporary clerk, and the necessary steps were taken to perfect the organization upon its new basis. A series of by-laws was adopted, differing in no essential sense from the old constitution, and the old board of officers were re-elected without change.

The necessary vote directing the officers to deliver to the new body all records, monies, etc., in their possession, was passed by the old organization. An exhibition of pictures was held by the Club in the gallery of the Boston Art Club, 64 Boylston street, the use of which has been kindly granted for this purpose during

the last week in March. The exhibition opened Tuesday, March 26, at 10 o'clock, A. M., and closed on Friday, the 29th, at 10 o'clock, P.M. Pictures of scenery among the mountains of New England were exhibited.

April 4, a special meeting was held to hear and discuss a paper by Prof. H. F. Walling on some recent views of mountain structure.

April 10, a communication from Prof. A. Lakes, on an ascent of Long's Peak, was read and an account of some barometrical observations in the White Mountains was received from Prof. F. W. Clarke.

CINCINNATI SOCIETY OF NATURAL HISTORY.—This Society held its regular meeting in its building, corner of Broadway and Arch streets, on Tuesday evening, 3d inst. This was the occasion for annual reports by the retiring officers, and the election of their successors. The report of the Treasurer showed a balance in the treasury of over $40,000, so invested as to produce an annual income of $3,500. The financial matters of the society have been very carefully managed by the Trustees, and hence these gratifying results. The Society owns its own buildings, and has no outstanding debts whatever.

The election of officers for the ensuing year resulted as follows: President, V. T. Chambers; Vice-Presidents, Prof. I. F. Judge and S. S. Cotton; Treasurer, I. A. Wright; Recording Secretary, Florien Giasque; Corresponding Secretary, I. W. Hall; Librarian, I. C. Shroyer; Custodian, Dr. I. H. Hunt. The Curators elected were as follows: Mineralogy, Dr. R. M. Byrnes; Palæontology, Ed. O. Ulrich; Botany, Davis L. James; Conchology, Prof. A. G. Wetherby; Entomology, I. W. Shorten; Ornithology. Charles Dury; Icthyology, Dr. D. S. Young; Herpetology, Frank W. Langdon; Comparative Anatomy, Dr. A. J. Howe; Astronomy, Prof. Ormond Stone; Physics and Chemistry, Prof. R. B. Warder; Meteorology, Prof. Geo. W. Harper; Microscopy, Fred. Eckstein; Archæology, Dr. H. H. Hill. The Society will now issue a regular quarterly journal of proceedings, the editors being Prof. I. F. Judge, Prof. G. W. Harper and Prof. A. G. Wetherby. The buildings are situated at the corner of Broadway and Arch streets, Cincinnati, Ohio, and are always open to the public.—*A. G. W.*

AMERICAN GEOGRAPHICAL SOCIETY.—March 21. W. Wright Hawkes, LL.D., delivered a lecture on the so-called Celtic monuments of Brittany.

ELMIRA ACADEMY OF SCIENCE.—March 15. Dr. W. H. Gregg remarked on time and the evolution theory, and F. Collingwood made a communication on the new moon of Mars versus the nebular hypothesis. Scientific progress in 1877 was then discussed, a phonautograph was exhibited, and singing and talking with Blossburg by telephones was listened to by the members.

NATIONAL ACADEMY OF SCIENCES.—This body convened in Washington at the Smithsonian Institution, on Tuesday, April 16, and remained in session four days, adjourning on Friday the 19th. The following papers were read before it:

"Formation and Structure of Alacrane Reef in the Yucatan Bank," by Prof. Alexander Agassiz, of Harvard College, Cambridge, Mass.; the Theory of Water-Spouts," by Mr. William Ferrel, of the United States Coast Survey; "Report on the Orbits of the Satellites of Mars," by Professor Asaph Hall, of the Naval Observatory; Mr. Raphael Pumpelly read a paper on "the Relation of Loess and Drift to Secular Disintegration;" "the Characteristic Invertebrate Forms of the Central Zoö-Geographical Province" by Dr. A. S. Packard, Jr. Dr. J. E. Hilgard, on "An Optical Ocean Salinometer." "Plan for Measuring the Velocity of Light," by Prof. Simon Newcomb, of Washington; "On the Force of Effective Molecular Action," by Prof. Wm. A. Norton, of New Haven, Conn.; "Remarks on the value of the result obtained for the Solar Parallax from the English Telescopic Observations," by Prof. C. H. F. Peters, of Clinton, N. Y.; "On the Vertebrate Fauna of the Permian Period of the United States, by Prof. E. D. Cope, of Philadelphia, Pa.; "On the discovery of Oxygen in the Sun," by Dr. Henry Draper, of New York City; "On Complex Inorganic Acids, by Dr. Wolcott Gibbs, of Harvard University, Mass.; "On improvements in methods of deep sea dredging, by Mr. Alexander Agassiz; "On Boyle's and Mariottes Laws," by Prof. Wolcott Gibbs; "On the Abrasions of the N. W. Coast of America," by Prof. Geo. Davidson, of San Francisco, Cal.; Photometric comparison of the Components of Close Double Stars," by Prof. E. C. Pickering, of Cambridge, Mass.; "On the Duplication of Geographical Names," by Dr. F. V. Hayden, of Washington; "Characteristics of some of the Lower Spectral Lines, by Prof. S. P. Langley, of Allegheny, Pa.; "A New Element of the Cerium Group, Prof. J. Lawrence Smith, of Louisville, Ky.; "On the Primary Zoö-Geographical Divisions of the Globe and their Relations," by Dr. Theodore Gill, of Washington; "On the Laws Governing the Movements of the Rocky Mountain Locusts," by Prof. C. V. Riley, Entomologist of the Department of Agriculture; "Photometric Measures of Certain Faint Stars and Satellites," by Prof. E. C. Pickering; "Recent Displacements in Utah, by G. K. Gilbert.

At the conclusion of Mr. Gilbert's paper, the Secretary read the address of the venerable and revered President, Professor Joseph Henry, to the Academy. After reading a number of papers by title, the proceedings concluded with a paper entitled "Supplementary notice on the paper whence came the inner Satellite of Mars?" read at the October session, 1877, by the venerable Professor Stephen Alexander, of the College of New Jersey, Princeton, N. J.

On the evening of the 17th, Prof. Arnold Guyot, of Princeton, N. J., read a paper on the Life of Louis Agassiz in America. Dr. Elliott Coues, in the absence of the author, read a Memoir of Prof. Jeffries Wyman, by Dr. A. S. Packard, Jr.

Communication was made by a representative of the subscribers to the fund, amounting to $40,000, presented to Professor Joseph Henry as a testimonial of their high appreciation of his services and his unselfish devotion to the cause of science, the principal of which is finally to go to the National Academy of Science, to form a fund to be known as the Joseph Henry Fund, the interest of which is to be devoted to assist the original research. The academy now holds a similar fund, "the Bache fund," the principal of which was left to the academy by its first President, Prof. A. Dallas Bache, and the income from it has been applied to the assistance of investigators in many of the most important branches of science. The list of contributors to the "Henry" fund, which is made up mainly in sums of $1000, embraces the names of well known persons in the large cities of the United States.

At a meeting of the Jewett Scientific Society of Lockport, N. Y., Jan. 25, 1878, Mr. A. F. Goodman read a paper on the sword-fish and its habits. Dr. S. F. Clark presented a paper recording his observations on ants. Feb. 8th, Mr. M. S. Burnett delivered a lecture on evolution, and Dr. A. W. Tryon remarked on the process of petrifaction.

Appalachian Mountain Club, May 8.—Prof. C. E. Hamlin read an account of Mt. Katahdin, Maine, illustrated by a model of the mountain. The councillors presented reports of their plans for the summer's work. A meeting of those wishing to form a section of exploration was held May 11th. On Saturday, May 18, 1878, an excursion was made to Blue Hill, Milton, Mass. On Wednesday, July 10, 1878, a field meeting will be held at the Fabyan House, White Mts., N. H.

American Geographical Society, April 16th.—Elial F. Hall read a paper entitled Gerard Mercator, his life and works, while addresses were made by the President of the Society, and others upon the state of geographical knowledge before Mercator.

Scientific Association of the Johns Hopkins University, April 3.—The regular exercises were contributions towards a history of Maryland Cambari, by Mr. Uhler; a paper on Nitro-sulpho-benzoic Acids, by Mr. Hart; Theory of Groups, by Dr. Story.

Boston Society of Natural History, April 17.—Mr. Richard Rathborn made an address on the late Prof. C. F. Hartt, and his Brazilian explorations.

Troy Scientific Association, April 15.—Dr. R. H. Ward read a paper on microscopic ruling and engraving.

SCIENTIFIC SERIALS.

American Journal of Science and Arts, May.—Descriptions of new genera and species of Isopoda, from New England, by O. Harger. Notice of new fossil reptiles, by O. C. Marsh.

Bulletin of Hayden's U. S. Geological Survey of the Territories. IV, No. 2. May 3.—The geographical distribution of the mammalia, considered in relation to the principal ontological regions of the earth, and the laws that govern the distribution of animal life, by Joel Asaph Allen. Description of new extinct vertebrata from the Upper Tertiary and Dakota formations, by E. D. Cope. Notes on a collection of fishes from the Rio Grande, at Brownsville, Texas, by David S. Jordan, M.D. A catalogue of the fishes of the fresh waters of North America, by David S. Jordan, M.D. Description of a Fossil Passerine Bird, from the insect-bearing Shales of Colorado, by J. A. Allen. (Plate I.) The Coleoptera of the Alpine Regions of the Rocky Mountain, by John L. LeConte, M.D. On the Orthoptera, collected by Dr. Elliott Coues, U. S. A., in Dakota and Montana, during 1873–74, by Prof. Cyrus Thomas. On the Hemiptera collected by Dr. Elliott Coues, U. S. A., in Dakota and Montana, during 1873–74, by P. R. Uhler. On the Lepidoptera, collected by Dr. Elliott Coues, U. S. A. in Montana, during 1874, by W. H. Edwards. An account of some insects of unusual interest from the Tertiary rocks of Colorado and Wyoming, by S. H. Scudder.

The Geological Magazine. April.—The age of the world as viewed by the geologist and the mathematician, by T. M. Reade. Geological time, by C. L. Morgan. What must be explained before the preservation of deposits under till is explained? by J. Young. Note on *Penæus sharpii*, by H. Woodward.

Quarterly Journal of Microscopical Science.—April. On the phenomena accompanying the maturation and impregnation of the ovum, by F. M. Balfour (with an important résumé of latest discoveries). Notes on the structure and development of osseous tissue, by E. A. Schäfer. On the endothelium of the body-cavity and blood-vessels of the common earth-worm, as demonstrated by silver staining, by D'Arc Power. Experimental contribution to the etiology of infectious diseases, with special reference to the doctrine of Contagium vivum, by E. Klein. On the nature of fermentation, by J. Lister.

Zeitschrift für Wissenschaftliche Zoölogie.—March 7. F. E. Schulze continues his researches on the structure and development of sponges (family *Aplysinidæ*). The development of feathers, by T. Studer. Fertilization of the egg of *Petromyzon planeri*, by E. Calberla. On the formation of the egg and the amles of *Bonellia viridis*, by F. Vejdoosky.